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THE ORIGIN OF THE STEAM ENGINE.

ALL works that treat of the history of the steam engine speak of the eolipile of Heron as the most ancient manifestation known of that power which to-day fills the world. But very few persons know that we also find in the *Pneumatics* of the Greek engineer the germs of the tubular boiler and of the Papin cock which has been replaced in modern engines by the long D-valve. Here, in the first place, is a literal translation of the two passages that have reference to the apparatus, so often cited, of Heron:

"*Balls may be held in the air by the following method:*

"Fire is lighted under a boiler that contains water and is closed at its upper part. From the cover starts a tube which rises vertically, and at the extremity of which a hollow hemisphere is in communication with it. On placing a light ball in this hemisphere it will happen that the steam, on rising through the tube, will raise the ball in such a way that it will remain suspended.*

"*To cause the revolution of a sphere on a pivot by means of a boiler placed over a fire:*

"Let A B (Fig. 2†) be a boiler containing water and placed over a fire. It is closed by means of a cover, $\Gamma\,\Delta$, which is traversed by a bent tube, E Z H, whose extremity, H, enters the hollow sphere, Θ K, in the direction of the latter's diameter. At the other extremity is placed the pivot, A M N, which is fixed upon the cover, $\Gamma\,\Delta$. There are added to the sphere, at the two extremities of one of its diameters, two tubes bent at right angles and perpendicular to the line, H N. When the boiler is heated, the steam will pass through the tube, E Z H, into the small sphere, and issuing through the bent tubes into the atmosphere, will cause it to revolve *in situ*."

The following apparatus, likewise described by Heron, but not so well known as those that precede, shows that the ancients employed steam (mixed with hot air, it is true) for causing liquids to rise. According to Father Kircher, who reports it on the faith of an author named Bitho, there was at Sais, Egypt, a temple dedicated to Minerva in which there was an altar upon which, when a fire was lighted, Dyonisos and Artemis (Bacchus and Diana) poured, one of them wine, and the other milk.

The miracle was performed as follows:

"*On lighting a fire upon an altar, figures make libations and serpents hiss* (Fig. 4).

"Let A B be a hollow pedestal upon which there is an altar, Γ, in whose interior there is a large tube, Δ E, that descends from the fireplace into the pedestal and divides into three small tubes. One of the latter, E Z, runs to the serpent's mouth; another, E H Θ, to a vessel, K Λ, suitable for containing wine, and the bottom of which should be above the figure, M, as this tube has to be connected with the cover of the vessel, K Λ, by a grating; and the third tube, E N Ξ, rises likewise to a vessel, O, suitable for receiving wine, and is connected in the same way with its cover. The two latter tubes are soldered to the bottoms of the vessels, and in each of these vessels there is a siphon, P Σ and T Υ. One extremity of each of these tubes dips into the wine, while the other, which ends in the hand of the figure that is to make the libation, traverses the side of the wine vessel. When you wish to light the fire, you will first put a little water into the tubes so that they shall not be burst by the dryness of the fire, and you will stop up all the apertures so that the air shall not escape. Then the blast from the fire, mixed with the water, will rise through the tubes up to the gratings, and passing through these, will press upon the wine and cause it to flow through the siphons, P Σ and T Υ. The wine issuing thus from the hands of the figures, the latter will appear to make libations as long as the altar is burning. As for the other tube, which leads the blast to the serpent's mouth, it causes the latter to hiss."

As regards the cock and the tubular boiler, we find these in a hot water stove which Heron calls by the Græco-Latin name *Miliarion*, because of its resemblance to a milestone.

FIG. 4.—HERON'S MARVELOUS ALTAR.

Fig. 3 shows us, in the center, the fireplace in the shape of a vertical cylinder, which should have beneath it an air vent that is not shown in the cut. All around this there is a boiler, likewise cylindrical, filled with water. A certain number of tubes, such as O K and M N, put its different parts in communication by passing through the fireplace, and thus increase the heating surface.

The cock, T, serves to let off hot water, and the funnel, Σ, to introduce cold water into the boiler through a tube which runs to the bottom of the latter. The object of the bent tube is to allow of the escape of air when water is poured in, and to give exit to the steam that may be formed, and thus avoid the ejection of water through the funnel, Σ. Heron, in his text, says that this tube debouches in the interior of the funnel so that it shall not be perceived, and not as we have shown it for the sake of greater clearness. In the figure there may be seen a compartment formed by two vertical plates that make an angle into which water cannot enter. This is designed for actuating different figures through the play of the steam and of the several way cocks that I have mentioned. This latter consists of two concentric tubes capable of revolving with slight friction one within the other. The external tube, $\Gamma\,\Delta$, is fixed to the upper side of the stove, and traverses it. It contains three apertures, φ, ψ, and χ, placed at different levels and communicating, through small tubes, with the figures that are to be presently mentioned. The internal tube, A B, is open at its lower part and thus communicates with the interior of the compartment, but is closed at its upper part, which latter debouches above the stove and may be maneuvered by the handle, A. It contains three apertures at the same levels as apertures φ, ψ, and χ, but differently placed, so that when, through a rotary motion of the tube, A B, one of them is brought opposite an aperture of the same level in the tube, T Δ, the two others do not correspond. The positions that it is necessary to give them in order that such correspondences shall occur are denoted by marks engraved on the visible portions of the tubes. The tube, φ, terminates in a serpent's head which bends toward the fireplace, and tube ψ terminates in a triton who holds a trumpet to his mouth. Finally, tube χ carries at its extremity a whistle that debouches in the body of a bird filled with water.

It will now be seen what will occur. The tube, A B, is removed and a little water is put into the compartment. This water flows into the tube, $\Delta\,\Xi$ (which passes under the fireplace and is closed at the side opposite its aperture, Ξ), and is converted into steam. When the tube, A B, has been replaced, the steam may at will be passed into the body of the bird, which will warble, or into that of the triton, who will blow his trumpet, or, finally, into that of the serpent, which will blow into the fire and quicken the flames.—*A. De Rochas, in La Nature.*

* Fig. 1 is borrowed from a MS. of the *Pneumatics* dating back to the Renaissance. The boiler should have been represented over a fireplace.

† This figure, likewise borrowed from a MS. of the Renaissance, is sufficiently clear to allow letters to be dispensed with.

BLASTING WORK IN THE DANUBE.

THE construction of the railway bridge across the Danube at Peterwardein involves a large amount of blasting in the bed of the river. The rock upon which part of the fortress of Peterwardein is built descends pretty steeply into the Danube. One of the piers of the bridge will have its foundation on this rocky slope, and it has been found necessary to level the rock for a length of 65 feet and a breadth of 26 feet, in order to be able to lower with the requisite precision the caisson for the pier foundation. As the rock to be removed is 23 feet below zero and the present level of the Danube about 40 feet below water, and as the current is running at a speed of 10½ feet per second, some idea may be formed of the difficulties of the blasting work to be done. The method employed by Major Lauer is consequently well suited to the operations needed. After several experiments, a guide-rod has been constructed which enables the workers to begin blasting operations.

FIG. 1.—HERON'S EOLIPILE.

FIG. 2.—HERON'S WHIRLING EOLIPILE.

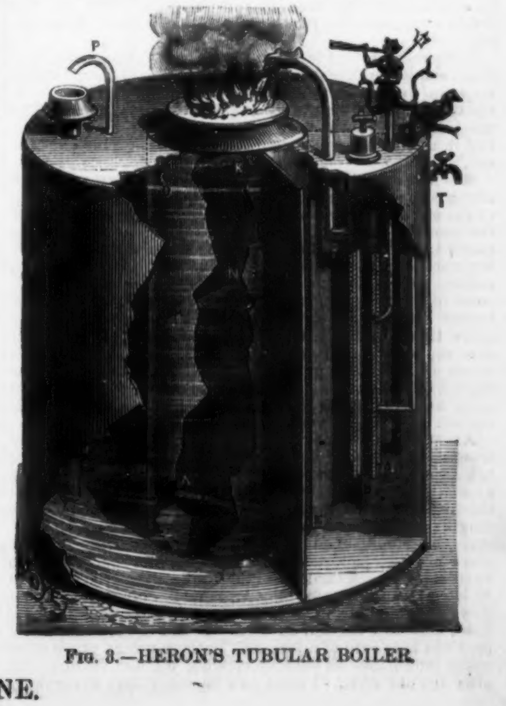


FIG. 3.—HERON'S TUBULAR BOILER.

THE ORIGIN OF THE STEAM ENGINE.

NEW RIG FOR STEAMERS.

By R. B. Forbes, Milton Mass.

SAY 368 FEET OVER ALL, TO HAVE FOUR IRON OR STEEL MASTS.

The mizzen or after mast to be 124 feet long, to carry a spanker or try-sail to brail in on boom and gaff and to be fitted to lower when required; a gaff-top-sail to hoist by hoops on the mast, or to have a yard and be hoisted from the deck.

The next mast, to be called the main, to carry three square sails, namely, a top-sail the drop of which will be about 27 feet, and the foot lashed to the lower yard 84 feet. I say "*drop*" because the sail is fitted to haul down to the lower yard and be guided down by jack-stays and down-hauls, and so be furled by few men. There will be no main course. The top-gallant-sail lowers on the mast by means of a tub parrel and furls to the top-sail yard; the royal lowers to the top-gallant-yard and is there furled or becketed as formerly done for royals. There is a main-stay, a top-mast-stay, and a stay leading from above the royal yard to the "middle mast," so that in lowering the royal and the top-gallant-sail close down to the top-sail-yard there is no stay to interfere. The lower yard is hung to a short crane-like attachment and parrels directly to the lower mast above the stay and the rigging, so that the yard can be braced as nearly fore-and-aft as it can be secured by braces and lifts. The top-sail-yard is also parreled to the mast above the rigging and does not hoist or lower.

The middle mast is of the same dimensions as the main-mast, say about 168 feet long by 28 inches in the partners, tapering gradually to 12 at the upper end. This mast will carry a large stay-sail abaft, is so fitted as to come down to the deck, and before it there will be a large lower stay-sail with a bonnet, and an upper one fitted to come down to the deck.

The fore mast is substantially like the main-mast, so far as the top-sail, top-gallant-sail, and royal are concerned; but it has in addition a square fore-sail fitted to set from the deck. The fore-mast being about 81 feet from the stem, and 154 in length, there will be ample space to set two-fore-and-aft-sails to advantage when the fore-sail is not set. There will be fore-and-aft stays from mast head to mast-head.

It will be seen by an examination of the plans, that in going to windward in strong breezes, all the fore-and-aft sails come to the deck to furl. The two top-sails furl on the lower yard, and the two upper sails—called royal and top-gallant sails—furl on the top-sail-yard; at this point there will be the three yards close together. Apart from this nucleus, if I may so call it, the yards being braced very sharp, there will be little top hamper to arrest progress. There may be short cross-trees near the eyes of the rigging, to afford a footing to men going up to furl the sails, and life lines, but no tops. As ocean steamers often get disabled in their machinery, there seems to be a necessity for considerable canvas. In coming to the westward in the winter, and in going eastward in the early spring, the yards on the main-mast may be kept on deck, perhaps all the yards, still leaving a considerable amount of fore-and-aft canvas available, and, perhaps, it will be well in the winter season to go without the royals. The three stay-sails in the center of the ship come to the deck, two on movable stays which trice up by tackles to the point where the standing stays set up; when to be taken in, these sails are first lowered to the mast, then the tricing tackle being let go the sail comes down to the deck, guided by a ring or rings, traveling on a rod, or batten, fixed to the mast. The mizzen or try-sail may have reefs in it, if necessary. The large stay-sails should have bonnets. There are jack-stays set up by lanyards, which are attached to the top-sail and lower yards, say three on each side as shown; the head of the top-sails is guided down by rings or bull's eyes attached to it, so that if all the six tricing tackles are let go, and the down-hauls pulled upon, the bulk of the sail comes down to the lower yard, and can be easily furled; the fore-sail comes to the deck by a similar process; in long stretches, or in trade winds, the fore-sail may be bent to the yard.

The principal advantages claimed for this rig are that there is no going aloft to furl any but the square sails, and the longest side of these, the foot, is always bent to the yard below it; there are no sheets and clew lines, and all can be easily taken care of by few men. It is well understood by seamen brought up in steamers that to clew up and furl square sails, fitted after the old plan, is a very difficult matter when it has to be done with a head wind. A passenger steamer competing with other fast ships must go straight; she cannot afford to change her course for one moment to accommodate the men in furling sails. This rig has fewer ropes, and the yards can be braced nearly fore-and-aft.

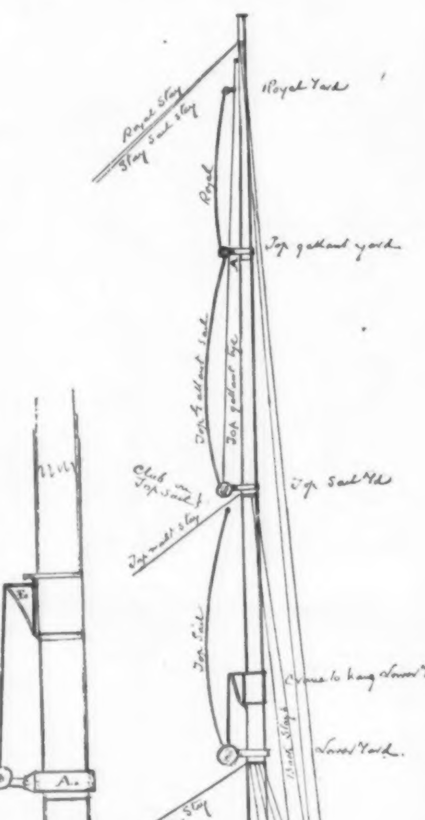
It is probable that in fully maturing my plans, I shall arrange something like cross-trees for the men to get a footing upon in furling top-sails. As these sails come down squarely to the lower yards, guided in a great measure by the jack-stays, fewer men can gather up the canvas and furl it, as compared to clewing up and bunting the old style sail.

It is not expected that the eye of the old seamen will be attracted by the beauty of the furl any more than that the eye of the old naval officer will be attracted by the symmetry of the modern war ship. In these days of iron and steel for masts and yards, we must forego any attempt at beauty, and we must stick to what is the simplest and best for modern sailors. The only question in my mind is, whether masts, some of which are nearly 170 feet in length, and say 26 or 28 inches in diameter, can be made stiff enough, and at the same time not to be too heavy; but when I look back a few years to what I saw in Liverpool I cannot entertain much doubt of the practicability of making them; it was there I saw the main-mast of a sailing ship, of about 1,500 tons, hoisted in with the top-mast and all the rigging attached.

As bringing courses on deck is something not generally done, I will describe my plan: To the head of the sail there are six purchases or tricing tackles; the two center ones are attached to a club spar, say about six or eight feet long; to the foot of the sail is attached another club spar of the same length; leading from the yard to the foot spar are two jack-stays, loosely attached, and from the head-earring cringles there are also jack-stays leading to the foot spar. To take in this sail the tricing-lines of the head-earring cringles are to be let go, thus bringing the two outer corners of the sail down to the foot spar, then lower away on the center tricing lines, and stow the sail on deck. It will be seen that a few men can take care of a fore-sail, by these means, much more easily than it can be done by clewing up, and furling aloft after the old style. I must now be understood as speaking for the sailors of a passenger steamer, which, like angels visits, are few and far between, and not for the well drilled crew of a ship-of-war.

The support of the top-sail yard, and the manner of arranging the parrels of all the yards, are illustrated on a separate sheet; an examination of this plan will show that the lower yard hangs to a crane which swings as the yard moves, and on the same angle; the top-sail-yard is hung by a wire rope tie to the mast-head; this rope passes through a hole in the neck of the parrel of the top-gallant-yard at the point, A, and the royal yard is parreled directly to the said tie. All the yards must, of course, have the usual means to facilitate their working, and the lifts of the top-sail-yard should come on deck so as to assist in holding the yard firmly in place.

It will be seen that when the top-gallant-sail and royal are to come in, the yards will run down freely to a point very near to the top-sail-yard; the heavier yard of the two should have the lifts so arranged as to hold its own weight, and not bring too much weight on the top-sail-yard, and its tie. The upper part of the mast, for about 60 feet, has no stay. It may be well to have the back-stays to set up by the tackles, so that when carrying sail hard there will be ample support, and, also, so that when the top-sail-yard is required to be braced very sharp, the sails being furled, there shall not be too much bearing on the lee back stays.



It will be advisable to have a main course to use in case of the machinery becoming disabled, also a receptacle in which to stow the courses when lowered.

NOTE.—COMPARATIVE NUMBER OF RUNNING ROPES.

The Old Rig.—	Fore-sail	11
	Top-sail	14
	Top-gallant-sail	8
	Royal	4
		37
The New Rig—	Fore-sail	15
	Top-sail	12
	Top-gallant-sail	4
	Royal	3
		34

The jack-stays to fore-sail, numbering four, are included, as they are running ropes.

The jack-stays of top-sail are permanent ropes, and not included.

In many ships the old style top-sail has two sets of halyards, and top-sails often have spilling lines.

HYDRAULIC MACHINE TOOLS.

At a recent meeting of the Institution of Civil Engineers, held on the 6th of March, Mr. Brunlees, President, in the chair, the first paper read was "On the Productive Power and Efficiency of Machine Tools, and of other Labor-Saving Appliances worked by Hydraulic Pressure," by Mr. Ralph Hart Tweddell, M.Inst.C.E.

The author stated that some years ago he had occasion to design a machine which was required to exert a great pressure in a confined space at a considerable distance from any shafting. The machine had to be portable, and to be capable of doing a large amount of work efficiently without the intervention of skilled labor. Such conditions were of common occurrence, and in this instance all were successfully fulfilled by the employment of hydraulic pressure. The paper was an amplification of the subject of the application of this power to actuating machine tools and other labor-saving appliances in engineering works, and was divided under three heads, namely, the introduction and development of hydraulic pressure machine tools, the productive power and efficiency of machine tools generally and the modes of increasing them, and the increased productive power and efficiency obtainable by the employment of hydraulic pressure for working machine tools and other labor-saving appliances. Reference was made to the unpublished experience existing on these questions.

Under the first head an illustration was afforded by a small portable hydraulic apparatus for fixing the ends of boiler tubes in tube-plates, the pressure of water employed varying from 1 ton to 1½ tons per square inch. Owing to the introduction of high steam pressure, the scantlings of marine boilers had to be considerably increased, but the mechanical riveting machines formerly in use were mostly inadequate to make steam-tight joints. In 1865 the author designed a hydraulic riveting plant to overcome the difficulty. It consisted of pumps, an accumulator, and a riveting machine, and in operation was seven times more economical than hand work; moreover, its surplus power was available for hydraulic presses for "setting," or joggling, angle and T irons. In action it was found that the material was much less strained, and that the wear and tear of the moulds and dies was greatly reduced, besides which the machines were movable.

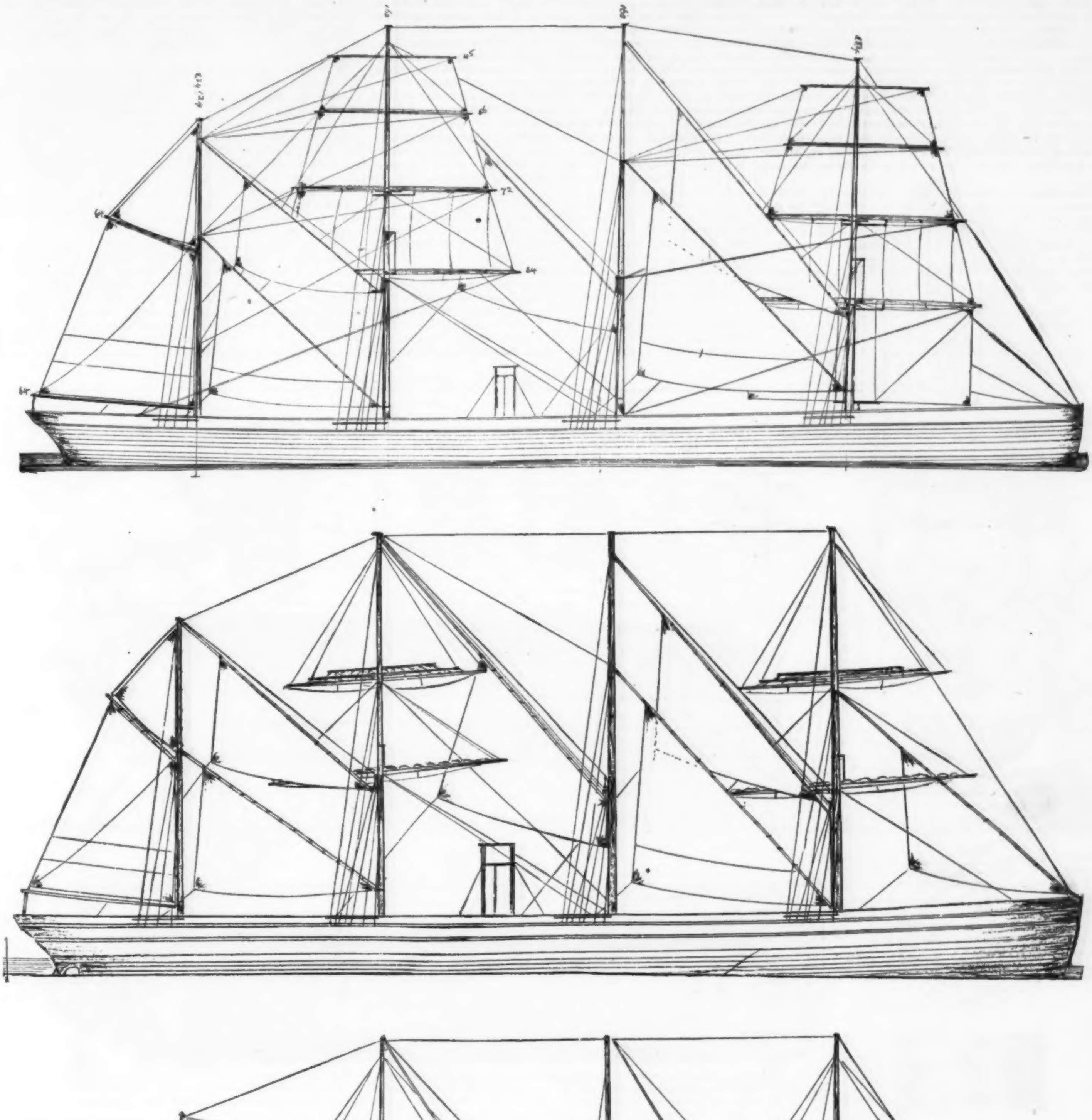
Previous attempts to perform similar work by portable machines driven by steam had not been very successful. This, it was believed, was the first hydraulic pressure riveting machine which could readily be applied at different points and over considerable areas, and at the same time maintain an uninterrupted connection with the accumulator pressure in the mains. The system had been extended to machinery of sufficient gap to span the deepest girders, the same hydraulic power which actuated the heavier machines being utilized for lifting them. The water driving these machines and their lifting apparatus was supplied under a pressure of 1,500 lb. per square inch. Among the first to employ them was the firm of Sir William Armstrong & Co. Several instances were then given of their application: for riveting *in situ* the lattice girder bridge which carried Primrose street over the Great Eastern Railway at Bishopsgate street Station; for riveting locomotive boilers; for fastening rivets in gun-carriages and in agricultural machinery; for railway wagon work; and for riveting ships. The substitution of hydraulic machinery for punching and shearing metals had been more gradual, but it had proved economical, and had been employed for shearing the links of chain cables, 3 in. in diameter, both sides at one time. To obtain the full advantages due to the application of hydraulic pressure to machine tools, the system should be applied throughout the works. This had been first carried out completely at the French naval dockyard at Toulon for building iron and steel warships. A similar plant had since been erected at the shipyard of the Forges et Chantiers de la Loire, at Penhouet, near St. Nazaire, illustrations of which were given, as also of another machine at Brest, which was now being constructed from the author's designs. Other applications of hydraulic pressure were then referred to, such as for forging and stamping. The author held that the successful carrying out of hydraulic forging would depend greatly on the skill brought to bear in making the dies and moulds.

As to the productive power and efficiency of machine tools generally, and the mode of increasing them, the author observed that the cost of manufacturing depended upon the productive power of the tools employed, and upon the possession of facilities for transporting the material to and from them. Ample lifting and transporting arrangements should be provided in all cases. At present a large amount of lifting was done by manual labor, in which there was room for great improvement. Owing to the necessity hitherto of using belting or gearing for working them, power cranes had only been applied to machine tools to a limited extent as a means for increasing their output. The author pointed out that, by the adoption of portable hydraulic machine tools, a great saving in floor-space might be effected. The introduction of hydraulic capstans had practically annihilated space in docks and railway yards, and as the haulage of a given weight on a good road required less power than lifting it, an extended application of such machinery to engine works was to be anticipated. The suitability of this system to increasing the output of large engineering shops and shipyards was evident, and safety in lifting was insured in hydraulic cranes by the impossibility of workmen putting on them a greater load than they were calculated to bear.

On the third head, namely, the increased productive power and efficiency obtainable by the employment of hydraulic pressure for working machine tools, the author observed that so far as the prime mover was concerned, the power necessary in a hydraulic system to pump water into the accumulator was nearly always obtained from a steam engine; but even at this early stage the hydraulic system, by the use of the accumulator, allowed of a considerable reduction in the size of the motor. A comparatively small prime mover, running continually, stored up sufficient energy to meet any sudden demand from even the largest of the machines worked from it; while on the other hand the prime mover would have to be equal to this. This defect was to a small extent met by the use of flywheels, which were, however, objectionable from their liability to accidents, and from the strains to which the shafting was subjected. From 200 to 300 blows per minute had been obtained in hydraulic machines, and in machine tools and cranes the accumulator acted as a perfect safety valve. Then, for the transmission of power to points distant from the prime mover, hydraulic pressure was the most economical. By the use of hydraulic mains laid underground, all overhead shafting was dispensed with. Under the present system the lines of shafting, to a great extent, regulated the position of the machines. In a recent case, 48,000 square feet were required with shafting, while 32,000 square feet only were necessary when arranged for hydraulic transmission. In this case the cost of all the roofing and flooring of a building 300 feet long, 53 feet wide, and 25 feet high was saved. A pipe of 1 in. bore could transmit nearly 6·5 horse-power at a very moderate velocity of water, and a 2 in. pipe about 25 horse-power. All danger from the use of belts and pulleys was avoided, and when once laid in the ground it needed no further attention.

The next question was as to the suitability of hydraulic pressure to actuating the tools. It had already been employed for slotting and planing machines, and its application to rotary machines might even become as economical as any other. The simplicity and fewness of parts in all hydraulic machine tools was a source of great economy. In respect to the economical application of force through each individual machine when performing such an operation as punching, the machine was moving at its lowest speed, and friction was at a minimum when most work was being done. Again, hydraulic machines consumed no power except when actually doing work, while it was not unusual in a machine shop to see all the shafting running in order to drive a small tool at

its extremity. With hydraulic machines it was immaterial whether the machine was 2 ft. or 2000 ft. from the accumulator; only the exact quantity of water necessary to perform the operation was consumed. In conclusion, the author stated that apart from questions of economy attention might be directed to several of the advantages arising from the application of hydraulic power to special cases. In riveting machinery it rendered it possible in one and the same machine to close the plates with a steady pressure, to fill the rivet-hole without forcing the metal of the rivets in between the plates, and to give the metal a sharp blow; not only could the heaviest machine be lifted, but the machines could be attached to their work. In punching and shearing machinery much greater accuracy was insured from the perfect control of the moving punch or knife, whose descent could be arrested even after it had touched the plate. Steel plates were less injured when punched by steady hydraulic pressure. Hydraulic punching and shearing machines required no foundations, and could be readily taken on board ship, thus saving much carrying to and fro of plates. It was often desirable to follow up the effects of a sharp blow by maintaining a continued, steady pressure. This was illustrated by the author, who described an "impact" accumulator, and pointed out the difference of effect of a number of light blows as compared with one heavy one in the case of hydraulic riveting. Similar conditions applied to forging. The indirect advantages due to the uniformity of all the work applied also to the flanging machinery, and in fact to everything passing through dies and blocks. He thought that even small firms might find it advantageous to combine in the erection of a common pumping station, and so to obtain many of the economical benefits due to carrying out operations on a large scale.



Head to wind under bare poles

FORBES' NEW RIG FOR STEAMERS.—ABOUT 368 FEET OVER ALL.

MAROT'S IMPROVED GRAIN-SEPARATING MACHINES.

AFTER thrashing, the cleaning of grain is one of the most essential and delicate operations to be performed mechanically. Not only must fragments of straw, dust, chaff, and other light bodies be removed, but also stones and such seeds as have become intermixed with the wheat.

To an inventor of great merit, Autoine Vachon, is due the credit of having devised a very remarkable apparatus, which has rendered, and is still rendering, the greatest service to agriculture and milling. This ingenious apparatus, which for a long time was styled the "Vachon separator," was first introduced to the public in 1845. Since that epoch, the machine has come into so general use that it has become a source of fortune to a number of manufacturers, who, appreciating all its advantages, have devoted themselves to constructing it of all sizes, either for running by manual power for farm use, or for running by steam in large mills.

These mechanical separators, as at present made, are true instruments of precision, and such is especially the case with the one improved by Mr. Marot, of Niort, which effectually frees wheat not only from stones, balls of earth, straw, and seeds, but also from other grain, such as barley, oats, and rye.

This new apparatus is shown in detail in the accompanying plate, which is reproduced from the *Publication Industrielle*.

Fig. 1 shows the machine in longitudinal section. Fig. 2 gives an external end-view. Fig. 3 shows a horizontal projection.

The principal part of this separator is an arrangement consisting of several concentric cylinders which revolve around a fixed axle, A, and which are mounted so as to incline slightly in the interior of the wooden frame, B. This latter serves also as a support for a hopper, C, into which is thrown the grain to be cleaned, and the front of which is provided with a register designed for regulating, by means of a set-screw and thumb-nut, the size of the passage through which the grain flows. This latter, on leaving the hopper, slides over a device, D, which eliminates the stones and straw, and separates the dust, etc.

The interior of the separator is traversed longitudinally, and beneath the fixed axle, by an endless screw, E, revolving over a channel, F, which is accompanied by an inclined plane, F', on to which falls the grain that is taken up by the cavities in the cylinder, and that the screw carries from one part to the other of the apparatus. The cylinders, G, H, and I, are all of the same length. One of them—that in the middle—H, is of sheet iron, even and smooth, while the other two, G and I, are of zinc and provided with hemisperical cells or depressions throughout their whole extent. The inner cylinder is formed of three distinct parts—of three unequal compartments, Nos. 1, 2, and 3, whose cells or cavities differ essentially in strusture and dimension, as may be seen from Figs. 6 to 11.

Between the two cylinders, G and H, is placed a spiral tube, J, which, beginning at the lower extremity of the apparatus, runs nearly two-thirds of the length of the latter, and preserves its form up to the entrance of the second compartment, but which, starting from this point, is prolonged in the form of a flattened spiral of the same pitch, and ends toward the head of the cylinder, that is to say, at the point where the grain is introduced. The importance of the role performed by this spiral will be seen further on.

We have said that the axle, A, which supports the separator is immovable; it is, in fact, fixed in cast iron bearings, *a*, at the two extremities of the frame. The cylinder, on the contrary, having to undergo a continuous rotation, is carried at the two ends of this shaft by two cast iron disks, *c*, and four iron radii, *b*, attached with bolts. On the same side with the principal driving-gear, the nave of the disk to the right traverses the first bearing, *a* (which is enlarged for that purpose), and carries externally a toothed wheel, *d*, which gears with a straight pinion, *e*. This latter is adjusted to a small axle whose opposite extremity is provided with a winch, *f*, or with a pulley, according as the apparatus is to be driven by hand or power. In the first case, the winch is provided with a click, *f* (Fig. 2), to prevent the workman from turning it in the wrong direction by mistake. The fixed axle, A, supports the channel, F, by means of several stirrup-irons, *x*, and the bearings, *y*, of the screw are affixed to the channel as shown in Figs. 4 and 5.

The small axle, *g*, to which the winch is attached is likewise provided with a second ratchet, *h*, the object of which is to give the sieve, D, a vibratory motion. For this reason, the latter is suspended by one end to the hopper, C, through a double hinge-joint, and connected by its opposite extremity to a vertical rod, *i*', which, guided by a piece, i^2, terminates in a wedge-shaped end that engages in the teeth of the ratchet-wheel, *h*. It is the passage of the teeth of this latter, then, under the extremity of the rod, that produces the vibratory motion of the sieve arrangement.

This sieve arrangement consists of two superposed parts. The upper, D^1, is a sieve with triangular meshes which allow the grains of all sizes to pass, while the stones, straw, and other foreign particles larger than the grain, being drawn toward the right extremity (Fig. 1), fall into a box, D^2, which throws them into a receiver, D^3, a sort of drawer that is emptied from time to time. The grains that have traversed the first sieve, D^1, fall on to the lower sieve, K, which has long rectangular meshes that are fine enough and close enough to allow only the tares and dust to pass. All the grain and other seeds reaching the lower part meet a sufficiently wide aperture to permit them to fall into the funnel, K^1, whence they are directed toward the first compartment of the internal cylinder, G.

The endless screw, E, is driven by the cylinder itself by means of two small gearings, d^1 e^1, placed at the lower extremity of the machine.

In spite of the shaking and sifting that it has undergone, the wheat still remains mixed with a certain quantity of small seeds and round seeds, and often with grains of barley, rye, and oats. It is necessary, then, not only to free it from these, but also to isolate each one of the latter so that they may be utilized separately. This is done as follows:

The first part of the internal cylinder—the one to the right—which forms compartment No. 1 (Fig 1), is provided with cells or depressions whose diameter is such that all kinds of grain, with the exception of barley and oats, may lodge therein. The result is that these latter, remaining on the lower side of the compartment, roll, through the effect of its slant, and fall at its left extremity into the receptacle, *j*.

During this time, the wheat, carried along with the other grain in the revolution of the cylinder, reaches the summit of the inclined plane, F^1, and falls with them into the fixed channel, F, which carries them successively, from right to left, as far as the end of compartment No. 1, where, through an orifice, *k* (Fig. 1), they empty into the second compartment. As the cells or depressions in this latter are smaller in diameter than those in the first, the round seeds alone can lodge in them. Consequently, these are taken up in the rotation of the cylinder and fall of necessity into the fixed channel or trough in order to be carried by the endless screw into the third compartment, where they drop through the orifice, k^2.

It should be stated that these round seeds are intermixed with a greater or less quantity of small seeds, which, like them, have lodged in the cells of compartment No. 2, and which, consequently, would travel to the same receptacle, m^1, if there were no means provided to separate them. To effect such separation the inventor has taken the precaution to reduce the dimensions of the cells of compartment No. 3, so that they shall be a little smaller than those of the preceding.

When these round seeds, mixed with wheat and rye, reach this cylinder (No. 3), they alone lodge in the cells and are carried up, free from wheat, into the channel or trough. From this they are carried along by the endless screw toward the extremity of the cylinder, and fall on to an inclined plane, *m*, which leads them into the receptacle, m^1. As for the wheat and rye, which, by reason of the small size of the cells, have not been able to lodge therein, they slide down the cylinder to the aperture, *n*. Reaching this point, they are still intermixed with some round seeds, since the very small cells of cylinder No. 3 do not readily take these latter up. It is necessary, therefore, that these kinds of seeds shall undergo another cleaning.

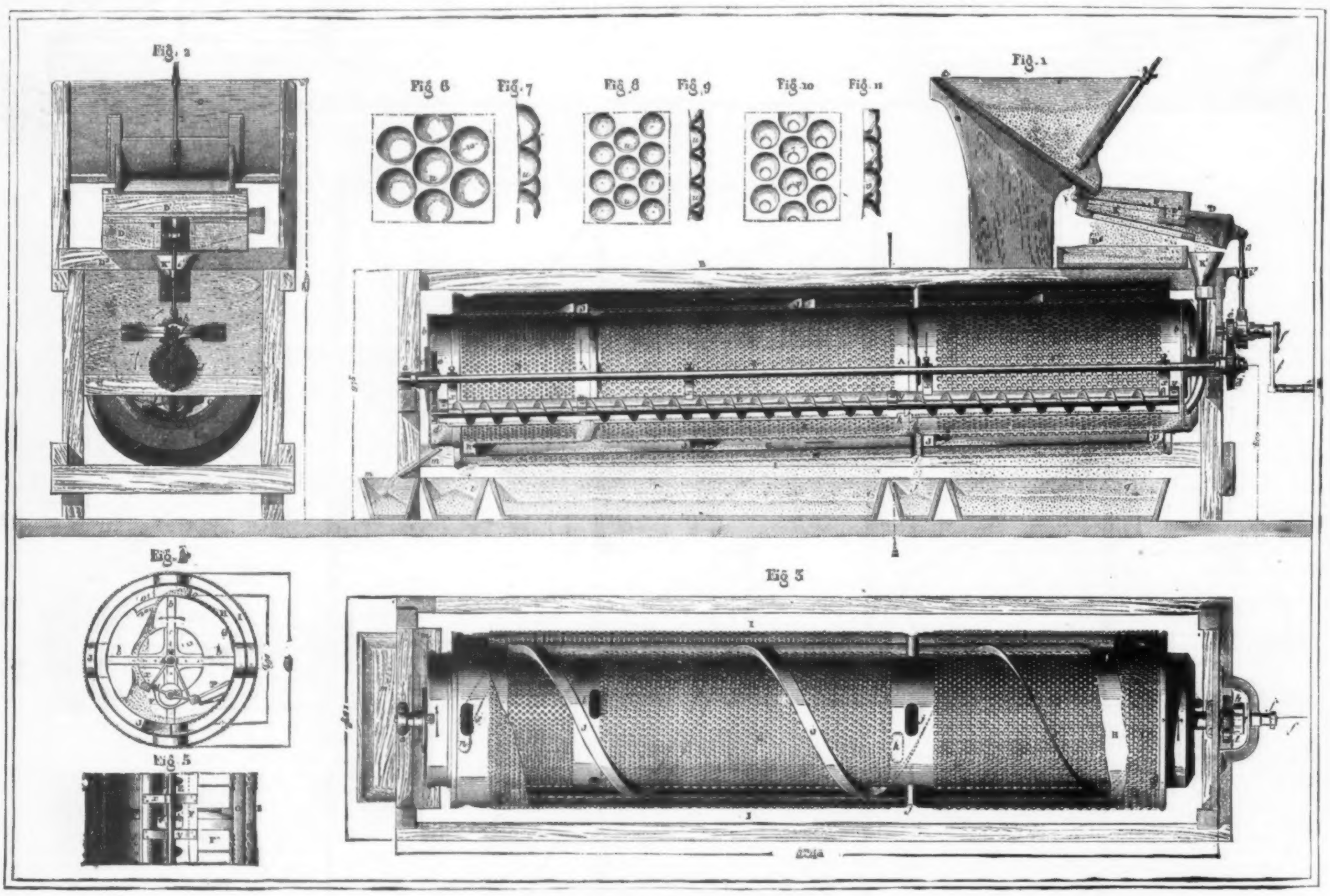
The aperture, *n*, is nothing else than the mouth of the spiral tube, J, whose role is, as we have seen, very important. As a consequence of the form of this tube, the grains that reach its mouth, *n*, are carried by the revolution of the cylinder up to the right of compartment No. 2. Here the spiral terminates in a partition, *o* (Fig. 4), in front of which there is an aperture, o^1, through which the grains enter compartment No. 2. As the grain and seeds must enter the latter only at the moment when the aperture, o^1, is in the position shown in Fig. 4, the space between *o* and o^1, in order that the grain shall not fall back into the channel, F, is so fashioned as to constitute a pocket which is capable of containing the whole of the small quantity of seeds that has been carried along by the spiral.

So, then, all the grain that has passed through the latter is submitted to a new sorting by passing for a second time into compartment No. 2. That which does not separate with the round seeds runs out, like the wheat and rye, through the orifice, *k* (Fig. 1), into the external cylinder, and is carried to the orifices, l^1, through which it falls on to the middle cylinder, H, which, as we have already seen, contains no cells.

Then all the grain that has passed through the orifices of H naturally reaches the end to the left, where it is stopped by the front surface of the spiral, and this latter obliges it to follow its curve, not only as far as the head of the second compartment, where the tube, J, ends, but also to the end of the cylinder, over the flat spiral, J^1, that forms its continuation.

Having thus returned to the head of cylinder, H, the grain, freed from seeds of all kinds, meets here an aperture, *p*, through which it falls into the external cylinder, I. This latter, as may be seen in Figs. 10 and 11, is pierced with small holes, which are not in the center of the cells, and which allow the grains of rye (that are of smaller diameter than those of wheat) to escape from the cylinder and fall into the receptacle, *q*.

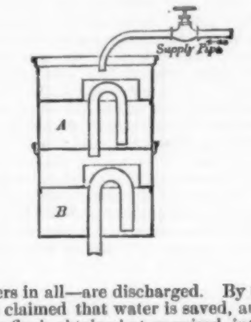
The same happens with the small and medium sized grains that did not separate along with the round seeds; these escape likewise from the holes and fall into the long receptacle, *r*. All the good grain, which, on the contrary, cannot traverse the orifices in the cells, is carried by the external cylinder, I, to the end of the machine, where it is finally received in a receptacle, *t*.



MAROT'S GRAIN SEPARATOR.

INTERMITTENT FLUSHING APPARATUS.

THE accompanying illustration, taken from the *Journal für Gasbeleuchtung*, shows the method of construction adopted by Herr F. Cuntz, of Karlsbad, for an apparatus intended for the intermittent supply of water to public lavatories, urinals, etc. It consists of two light cast-iron boxes, A and B, both provided with a siphon tube. The lower division, B, contains 7 liters of water, and has a siphon 25 millimeters clear diameter, which only works in conjunction with and is regulated by the upper siphon. This higher siphon is only 13 millimeters in diameter, and discharges at the rate of half a liter per minute. So soon as the upper division, A, is filled with water by the supply-pipe, it immediately empties itself by the siphon, and thus nearly fills the lower vessel. Upon the second discharge of the upper division, the lower siphon is set in action, and commences to pour out a strong flushing stream until the contents of both the



vessels—12 liters in all—are discharged. By the use of this apparatus it is claimed that water is saved, and at the same time a stronger flush obtained at required intervals. It has been tried in a public urinal, where formerly, on the constant supply system, 20 liters of water ran per minute, or 28·8 cubic meters daily. Two of these appliances were fixed, and regulated to discharge 24 liters every five minutes. Both discharge therefore only 3·45 cubic meters daily between them, and thus save 22 cubic meters of water per day in comparison with the former arrangement. The flush is very strong, for the 24 liters run off in 9 seconds. A similar arrangement to hold 6 liters is suitable for public water-closets, and for school or hospital use. It is certain in action, for it has no moving parts, and is very cheap.

ULMANN'S WASTE WATER ABSORBER.

THE object of the apparatus which is shown in the accompanying cuts, and which is the invention of Mr. Ulmann, of Zurich, is the prevention of any accumulation of waste water in the pipes of steam engines, and consequently the preservation of the steam in a dry state. The apparatus may be applied to all steam conduits, such as those of heating apparatus, etc.

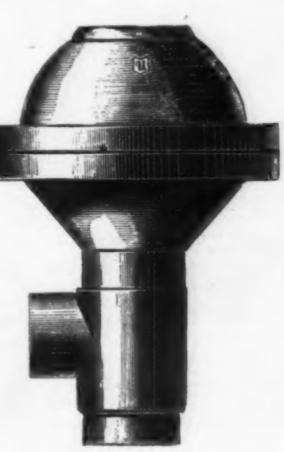


Figure 1.

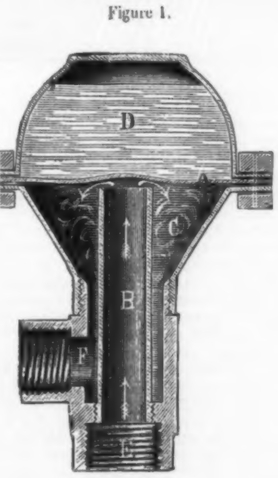


Figure 2.

The absorber is based upon the property that certain liquids possess of rapidly expanding or contracting under the influence of variations in temperature. The liquid is placed in a vessel, D, hermetically closed, and the bottom of which consists of a metallic diaphragm, A. This vessel is affixed to a funnel, C, which is screwed to a coupling, F E, which is itself screwed on to the steam pipe, or rather on to a waste water accumulating reservoir arranged at some point along the steam pipe. When there is steam only in the pipes, it enters as far as the diaphragm, through the pipe, B, and the liquid expanding, the diaphragm is caused to rest on the extremity of the said pipe, and thus to hermetically close it. On the contrary, when the waste water, on accumulating, touches the diaphragm, the liquid contracts, because the temperature of the condenser is less than that of the steam, and the diaphragm on falling back lets the liquid pass so as to flow off through the pipe, F. As soon as the water has passed, and the steam has come in contact again with the diaphragm, the pipe, B, closes anew.

The apparatus should be placed at the lowest point of the steam pipe, and the reservoir on to which it is screwed should be as large as possible, so that the waste water may become rapidly cool therein. It would prove an advantage to place in front of this reservoir a stop valve, so as to be able to take the apparatus off, or to stop its operation at will. If the waste water issuing through the aperture, F, is to be transmitted to a certain height or distance, minimum in all cases, the purge pipe will have to be provided with a valve, so that the water cannot flow back.—*Chronique Industrielle.*

FLYING.

To the Editor of the Scientific American:

A writer in the N. Y. *Sun* despairs of "Homo volans," and you seem to agree with him; but you both forget that there are two ways of flying—the one as the turkey flies, the other as the turkey buzzard flies.

The turkey weighs twenty-four pounds, and the surface of his wings is equal to six square feet. He cannot sail. The buzzard weighs four pounds only, and the surface of his wings is equal to six square feet.

The turkey has to support on the air four pounds to each square foot of surface. The buzzard supports only two-thirds of a pound to the square foot. The turkey uses a lever of the third kind where the power and the weight are very near together, and the fulcrum at a great distance acting with a mechanical disadvantage, in other words, requiring a muscular power of two hundred and forty pounds to support twenty-four pounds. It is clearly impossible for man, with all the combined power of arms and legs, to support himself in that way. It would require a power of fifteen hundred pounds. But now let us analyze the turkey buzzard, who spends hours in the high air without exerting any muscular power whatever except to steer his aerial ship. He has eight times more surface to the pound than his namesake on the earth, and when sailing against the wind at twenty-four miles an hour he can rest as easily on the passing air as his brother below on the solid earth. His long wings with their forward part depress six feet of air, and his wing feathers being elastic, turn upward in the rear to the elastic air; and his pressure forward equals the pressure backward, and being smoother, friction is reduced to nothing, as in the great wave of the Atlantic, which travels one thousand miles an hour, as an embodiment of force or weight, while the water does not advance at all. Now we come to the great difficulty of man's imitating the sailing buzzard. If four pounds in the sailing bird must depress six feet of air all the time, man would require a pair of wings two hundred feet from tip to tip. This is impracticable. The wings would break in two or be unmanageable. We have seen that man cannot fly, like the turkey, by great force; and now we see that he cannot make and manage wings long enough for his weight. Shall we then give him a *square* surface of wing, say twenty feet square, equal to four hundred square feet? But that arrangement will not depress *suddenly* enough air, and only the front twenty feet would give much support by its sudden impact to the air. It is true that a man under a horizontal sheet twenty feet square, in still air, would not descend to the earth as fast as a buzzard would, though his wings were spread out. But the buzzard does not descend at all while in rapid motion, as thereby his weight is supported by depressing a great deal of air in a given time. Now, what will you do about that trouble? I answer triumphantly: Cut the two hundred feet of narrow wings into ten equal parts, and place one above the other in a vertical frame, and still better, make the wings only six inches wide and double the number; still better, only one inch wide, and increase the number, and place them closer together, and you may surpass the sailing bird, sailing on the air, as much as you do the whale swimming in his native element by your artificial substitutes—flotation without gas. Man should have universal dominion. Dry up your tears of despair. Let us cherish the turkey as the noblest bird *for the table*, though he has no business in the high air, and let us admire and imitate the buzzard *as a sailer* and ready scavenger, while we do not, as Prince Murat did, so far forego all prejudice as to have "buzzard soup" brought to our tables. He admitted that it was not to be compared with turkey. Having flotation without gas, a man with his legs is able to fly off with his wife and children safely, and with his hand to steer up or down with ease. A vertical frame twenty by forty feet, holding one hundred and sixty wings, would take four men to the north pole and fetch them safely back. Let some man of science and charity try it.

Now, Mr. Editor, I ask the *Sun*, I ask *your* 150,000 scientific readers, to find an error in my position—that man can fly and surpass the birds.

CHARLES MCDERMOTT.

Centreville, Mississippi.

DE REDON'S ROUND ELECTRIC BELL.

UP to the present time, the form given electric bells has not varied much, it having been always that of a square box over which was suspended a gong. This form, although generally adopted, has two inconveniences: On the one hand, it is not very elegant; and on the other, it works well only in a vertical position, and cannot be employed in places submitted to vibrations, for example, on a railway train.

As for the form, attempts have been made to remedy this by different arrangements. Among other things, attempts have been made to give the general arrangement, base and gong, a hemispherical form; but no success has been attained except in giving a special shape to the hammer-rod, and the bell has always been one that would operate in but one position.

As regards resistance to vibrations, we scarcely know of any type of bell exhibiting this quality, and being able consequently to operate on trains, except the one devised by Mr. Napoli.

The three defects that we have above pointed out in the ordinary electric bell have just been corrected very ingeniously by Mr. De Redon in the apparatus shown in the accompanying cut.

The entire mechanism of the bell is contained in a sort of two-parted box, SS, forming a base. The gong, which is carried by a central rod, surmounts this base, and the whole thing thus exhibits a hemispherical appearance.

The peculiarity that this arrangement presents is the manner in which the hammer, B, is connected with the armature, A, through the steel spring, R, which latter is fixed at its two extremities beneath the metallic base that supports the electro-magnet. It is this same spring to which is fixed the armature, A, which latter it tends to draw back; and out of it is cut a small tongue, L, that carries a small piece of platinum designed to form a contact with the screw, V. It contains at its upper part a pretty wide slit through which passes the central rod, and which allows it to move to the right and left of the latter.

It is easy to conceive that, when the armature is attracted, the spring will be inflected toward the right, and the hammer, B, will strike the gong, T. The motion of the armature continuing, the spring will take a certain bound, and the travel of the hammer will become greater in reality than the distance that separates it from the gong when at rest. The screw, V, which serves to regulate the interrupter,

DE REDON'S ROUND ELECTRIC BELL.

is fixed in its support, C, at a height that corresponds exactly to the aperture left between the base and the gong. By means of a small screw-driver, then, the apparatus may be easily regulated without taking it apart.

The entire affair is mounted on three small supports, and is capable of operating in the position shown in the cut. It is likewise provided with appendages that permit of its being hung from a hook against the wall.

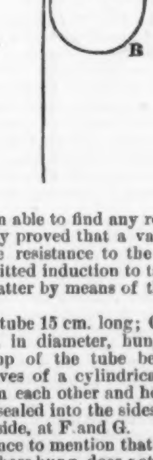
The very small dimensions of this bell, and its elegant appearance, render it very applicable in cases where a certain decorative effect is sought. It is well adapted, for example, to telephonic apparatus, in which an endeavor is made to group all the parts so as to produce as agreeable an effect upon the eye as possible.

It is capable of operating, moreover, in all positions, and resists perfectly well all vibrations. This latter feature renders it applicable to railway trains.—*La Lumiere Electrique.*

[NATURE.]

INFLUENCE OF A VACUUM ON ELECTRICITY.

THE theory of Prof. Edlund that a perfect vacuum is a perfect conductor of electricity, but that a discharge across such a vacuum between two electrodes is prevented by an electro-motive force at the surface of the electrode, involves our attributing to the vacuum the property of screening from electrical influence any body which it envelops. If the vacuum be a conductor, what we call induction cannot take place through it.



Not having been able to find any record of an experiment which conclusively proved that a vacuum so perfect as to offer considerable resistance to the passage of a current nevertheless permitted induction to take place through it, I have tested the matter by means of the apparatus shown in the figure.

A B is a glass tube 15 cm. long; C is a light hollow platinum ball, 1 cm. in diameter, hung by a fine platinum wire from the top of the tube between D and E, the two separated halves of a cylindrical platinum box, which are insulated from each other and held in position by platinum connections sealed into the sides of the tube, and projecting to the outside, at F and G.

It is of importance to mention that the upper terminal, H, from which the sphere hung, does not reach more than about 3 millimeters above the inner surface of the tube. The two halves of the cylindrical box are sufficiently near together to prevent the ball coming in contact with the sides of the glass.

This tube was exhausted until an induction current would give a 12 millimeter spark in air rather than pass between

two terminals, K L, sealed in the upper part of the tube with their opposed ends about half a centimeter apart.

A wire about 30 cm. long was then hung from F, and an electrified body presented to the lower end. On the approach of this body to the wire the sphere was at once attracted toward D, and when a discharge was permitted between the electrified object and the wire, the sphere was violently attracted, and a minute spark was seen when the wire holding it touched the cap of the box, D. The sphere was then repelled by the similarly charged box.

It thus appears that the phenomena of electric induction take place across a discharge resisting vacuum, and that the sphere hung in it is not screened from electrical influence as it would be if surrounded by a conductor.

A. M. Worthington.

Clifton College, Bristol, February 22.

ELECTRICITY ON TRAMWAYS.

The success which has attended the electrical tramways at Berlin, Brussels, Dusseldorf, etc., worked on the Siemens plan, by a stationary generator and a movable motor, has directed the attention of tramway officials to the use of electricity. It is well known that horse-power is expensive, not to speak of its cruelty, and neither steam nor compressed air has as yet made good its claim to be used in this application. The experiments of Plante, Faure, Sellon, Volckmar, and others in the direction of storage have culminated in an attempt to use electricity in this way for tramway work. A series of successful experiments have lately been carried out on the Acton tram line.

It will not be out of place to give the views expressed at the recent luncheon at the Star and Garter Hotel, Kew Bridge, as reported in *The Electrician*. A large number of gentlemen interested in the work were present, the chairman, Sir D. Cooper, of the Electrical Power and Storage Company (the host of the day), presiding.

At the request of the chairman, General Hutchinson gave his experience at the earlier trials on the Acton Road. He stated that the car ran satisfactorily at the rate of about six miles an hour. The speed was thought to be good, as the car was carrying about five tons weight. It might be necessary to alter one or two details after the morning's experience, but it was not expected that the Board of Trade would make any difficulty in licensing the running of these cars.

Sir F. Bramwell proposed "The Success of Electricity," coupling the name of Dr. Siemens with the toast. Sir F. Bramwell pointed out that the applications of electricity were rapidly extending. It enabled us to talk and write at a distance. We were even able to grow vegetables by its use. Electricity had certainly developed wonderfully during the past few years. He knew of nothing that had made such great progress.

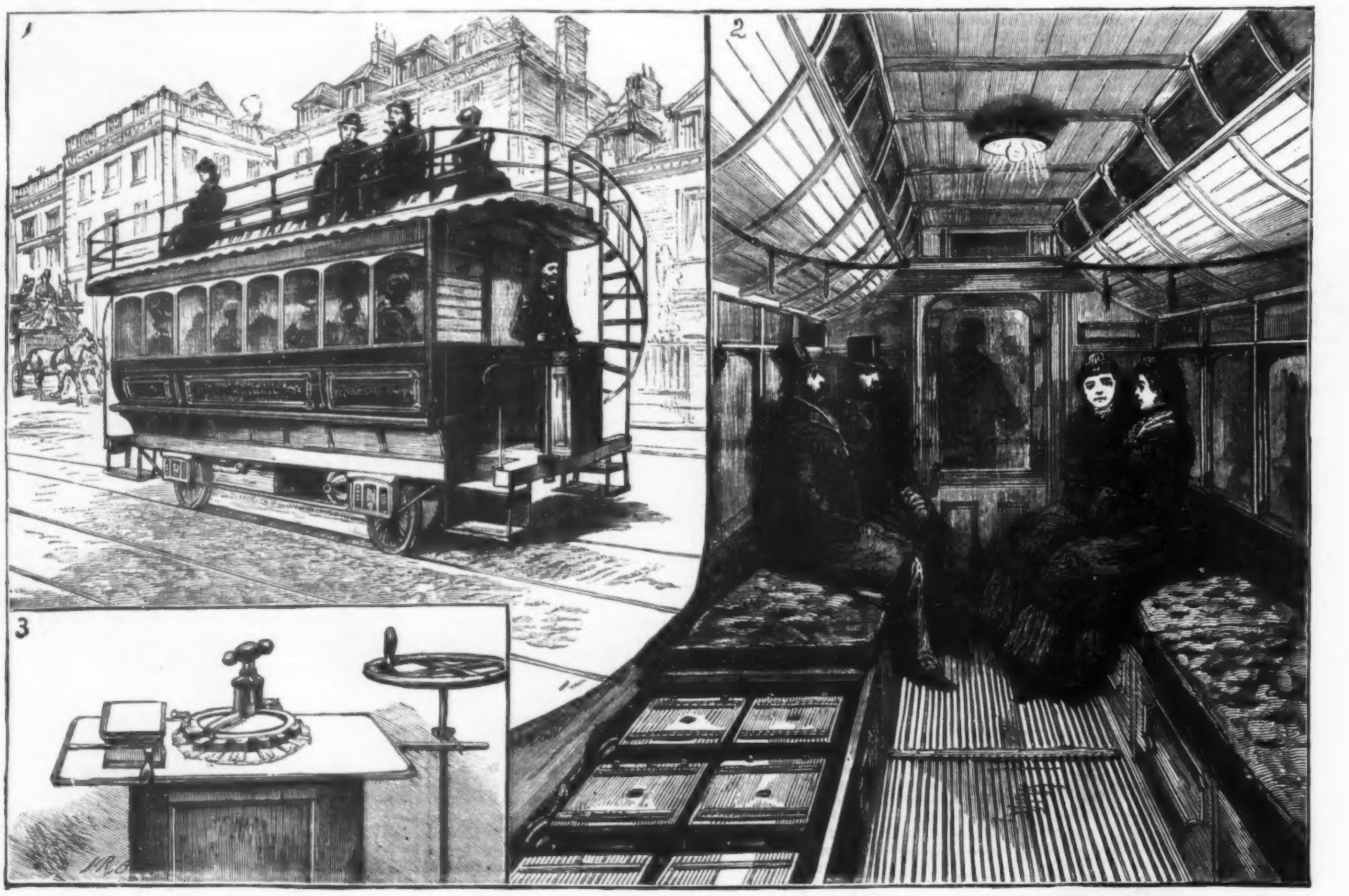
Dr. Siemens remarked that he had probably been connected with the applications of electricity longer than any other gentleman in the room. It was in 1843 that he first came into contact with Mr. Elkington, of Birmingham, and began to move in the domain of applied electricity. They had seen the telephone doing its wondrous work in carrying their voices to great distances, and they had now to witness the power of electricity in carrying them along in a tramcar. The electric railways with which he had been connected had run at the rate of twenty-five miles an hour. In Ireland one had lately been inspected by General Hutchinson, and was just about to be opened for traffic. The tramcar had to carry its own store of power. This would be charged into the car at convenient stations. Such a car would run upon common roads as well as on railroads. A much smoother movement was experienced in a tramcar propelled by electricity than that in an ordinary tramcar.

Mr. Noel, M.P., in proposing "Success to the Electrical Power Storage Company," said: Great as the advances in electricity have been, we have not yet discovered the means of effectively storing power when it has been generated. Once get the power of storage, and it can be used in large or small quantities. He coupled with this toast the name of Mr. Sellon, one of the inventors, a gentleman with an intense love of science, and one who had devoted a great many years of his life not only to science generally, but to electrical science in particular; also the name of Mr. Volckmar as a co-operator.

Mr. Sellon, in reply, gave a detailed account of the work and estimated cost as applied to tramcars. After referring to difficulties encountered, and he hoped overcome, he went on to speak of the economy of electricity. In round figures it might be taken that, by the employment of electrical apparatus, an effective return of 50 per cent. was secured out of the steam horse power taken from the stationary steam engine, and if the latter cost one halfpenny per hour, the effective horse power on the pulley of the working motor was obtained at as low a cost as one penny per hour. Assuming that each ton of weight of a tramcar with its load required one horse power traction, an average force of five horse power would be more than sufficient for a car and 40 passengers, and taking the working day of a car at 15 hours, the cost is shown at 75d. for 75 horse power hours, or, in other words, 6s. 3d. per day for traction. The actual daily cost of horsing a tramcar was given by some of the metropolitan companies at 26s. The difference between the 6s. shown above as the cost of electrical power and the 26s. paid for horses affords such a margin that, after abundantly providing for sinking fund, depreciation, repairs, contingencies, etc., a very great saving is effected. Another great public convenience was obtained in the means of lighting the car from the same accumulators used for the motive power. Where water or other natural power might be brought to bear there was no daily consumption of fuel, and the only outlay was really the sinking fund for depreciation of the machinery.

The following information has been supplied by the Electrical Power and Storage Company: "This tramcar is fitted with an accumulator consisting of 50 Faure-Sellon-Volckmar cells, each measuring 13 in. by 11 in. by 7 in., and weighing about 80 lb. The accumulator is capable of working a tramcar with its full load for half a day, or in other words seven hours. When charged it contains about 530 ampere hours, of which 400 are withdrawn with the greatest regard to economy. The accumulators are stored under the seats of the car, and the current is communicated by insulated wire to a Siemens dynamo machine acting as a motor, and connected with the axle of the wheel. Therefore, as soon as the communication between the boxes and the dynamo machine is effected, the electric current being led into the dynamo motor sets the armature of the motor in revolution, and the power is conveyed to a pulley fastened on the same axle as the armature. The Siemens motor works most favorably with an electric motive force of 100 volts and a current of 60 amperes, equal to 6,000 volt-amperes or watts, and as 746 watts constitute an electrical horse-power, the result is a consumption of eight electrical horse-power, and a yield on the pulley of five and three-fifths electrical horse-power. The action of the motor may be reversed at will, and the power may be increased or diminished as required by adding to or taking from the number of cells composing the accumulator by means of a simple switch, and by breaking the circuit the motive power is stopped, and the brake being then applied the car is almost immediately brought to a standstill. The cost of horse-power produced from a stationary steam engine of large size has been ascertained, and is universally accepted as one halfpenny per horse power hour. Five hundred steam horse-power would, therefore, cost 250 pence, equal to £1 0s. 10d. per hour. This power would be applied to the working of electro-dynamo or generating machines.

One of the best known inventors claims that he can supply a dynamo which will give on effective return of 95 to 97 per cent. of the power given to it. Without calling in question the accuracy of this pretension, it would be obviously unfair to adopt it as the basis of a calculation, and as there are many dynamo machines in the market which give a return of over 80 per cent., that is a more certain proportion to work upon. From 500 steam horse power given to the dynamo, a return would therefore be obtained of 400 electrical horse power. The dynamo would be worked to charge electrical accumulators, which in turn work an electric-dynamo motor machine, from the fly-wheel of which the direct power is obtained. It is ascertained that when 25 per cent. of the maximum charge which the accumulators are constructed to receive is permitted to remain in them they attain their best working efficiency, and the 75 per cent. may be withdrawn at a loss of not more than 10 per cent. on the quantity so withdrawn. Of the 400 electrical horse power given by the dynamo to the accumulator, the accumulator would give to the motor 360 electrical horse power. The Siemens dynamo when used as a motor gives a return of 75 per cent. of the energy put into it, but taking only 70 per cent. the 360 electrical horse power given by the accumulators to the motor will yield on the pulley of the dynamo 252 effective horse power. In round figures, consequently, it may be taken that by the employment of electrical apparatus an effective return of 50 per cent. is secured out of the steam horse power taken from the stationary steam engine, and if the latter cost one halfpenny per hour, the effective horse power on the pulley of the working motor is obtained at as low a cost as one penny per hour. Assuming that each ton of weight of a tramcar with its load requires one horse power traction, an average force of five horse power would be more than sufficient for a car and forty passengers, and taking the working day of a car at fifteen hours, the cost is shown as seventy-five pence for seventy-five horse power hours, or, in other words, 6s. 3d. per day for traction. It must be borne in mind also that out of the fifteen hours there would be about three hours stoppages, and that the electrical energy is only expended when the car is actually in motion. If the question be asked, "What are the relative initial or first costs of horses, steam, and electrical machinery for tramcars?" the answer is that they will be almost identical, but that the last named will have the advantages of requiring less space and a smaller number of assistants, combined with an immunity from those epidemics which at times incapacitate the stud of a tramway company. The actual daily cost of horsing a tramcar is given by some of the metropolitan companies at 26s. The difference between the 6s. shown above as the cost of electrical power and the 26s. paid for horses affords such a margin that after abundantly providing for sinking fund, depreciation, repairs, contingencies, etc., a very great saving is effected. Another great public convenience is obtained in the means of lighting the



1.—The Car.—2.—The Interior of the Car, with one of the Cushions removed to show the Accumulators.—3.—The Starting and Reversing Handles.

THE NEW ELECTRIC TRAMCAR AT KEW BRIDGE.

car from the same accumulators used for the motive power. Where water or other natural power may be brought to bear there is no daily consumption of fuel, and the only outlay is really the sinking fund for depreciation of the machinery.

THE APPLICATIONS OF ELECTRICITY.

THE second of the series of six lectures on the applications of electricity was delivered at the Institution of Civil Engineers, London, on March 1, by Sir Frederick Bramwell, F.R.S., V.P.Inst.C.E., the subject being "Telephones." The following is an abstract of the lecture:

Prior to the invention of the telephone, by making and breaking circuit at the transmitting station sounds had been produced at the receiving station—such as the striking of bells, or the vibration of a Morse sounder—but these were independent of sound at the transmitting station, and they varied according to the implement used at the receiving station, and were and are used for purposes of audible telegraphy. Also, prior to the invention of the telephone, it was possible to reproduce at the receiving station, say by a tuning-fork, the vibrations of which break and make contact, the same note produced by a similar tuning-fork at the transmitting station; and in this case there was a reproduction at the receiving station of the sound at the transmitting station. But the only thing that was insured was the repetition of the same note—there was no reproduction of the same sound. For example, the note might have been uttered by a violin-string, by a tuning-fork, or by a clarionet at the transmitting station; at the receiving station, however, nothing would be given forth but the note of the particular tuning-fork, or other vibrating implement, which was in accord with the number of the vibrations transmitted in a given time. All these modes were due to the variations of the current caused by break and make in the circuit, and were therefore abrupt. The best result obtained with such an agency was in the machine of Reis, who, in 1862, reproduced tones, and it is said some words were heard. That machine received no development, and telephony lay dormant for fourteen years, until the invention of Professor Graham Bell, patented in this country in December, 1876.

In 1874 Mr. William Henry Barlow, F.R.S., Past-President Inst.C.E., turned his attention to the recording of the vibrations produced by speech. He effected this by means of an instrument called a logograph. This was communicated to the Royal Society, and exhibited in operation there. By its agency there was depicted on a traveling band of paper the motions derived from the vibration of a membrane under the influence of speech; but had the results been known they would probably have deterred an inventor seeking to produce a telephone, as it appeared the vibrations were not always the same for the same syllable, but varied with the speaker and from the circumstances.

Professor Graham Bell graphically represented the variations in the electric current, either direct or reversed, caused by break and make, and showed that these were too abrupt for his purpose—namely, the reproduction of articulate speech. He proposed to attain the object sought by having the circuit always closed, and by causing rises and falls, or reversals, as the case might be, of electricity, which should be made gradually, instead of abruptly, as before. The simplest mode in which he attained this end was in one of the original forms of the Bell transmitter or receiver (for the instrument was capable of fulfilling either function) by placing an iron or a steel plate in the neighborhood of a permanent magnet surrounded by a coil of insulated wire, so that on the plate being set into vibration by the voice it should induce, in the coil, reversed currents of electricity which could travel along the wire in prolongation of the coil to the coil of the similiar instrument at the receiving station, thereby varying the power of the magnet at that station and setting up vibrations in the corresponding iron disk. This disk, acting upon the air, gave to it vibrations similar to those which had put the first disk into motion, and in that way a reproduction of the original sound (as Professor Bell said, a facsimile) was obtained. Other modes were employed by him, such as the use of a battery in the line-wire, and, best of all, the use of two local batteries to send the current to a primary coil round a core, the line-wire being connected with secondary coils acting by induced electricity. As transmitters these instruments were necessarily somewhat feeble, since the whole of the electricity in the first of the three cases mentioned, and what might be called the operative electricity in the other two cases, had to be derived from the microscopic movements of the disk, under the influence of the sound-waves produced by the speaker.

Edison's phonograph was exhibited, in order to show that a disk, when caused to vibrate under speech, could by a central needle impress those vibrations on tin foil, and that on the tin foil being caused to traverse under the needle, the reproduction on the disk of those vibrations caused it to repeat the speech which had originally set the disk in motion. This was appealed to as a convincing proof that a disk, when mechanically vibrated in a manner corresponding to the vibrations which had been imparted to it by speech, was sufficient, wholly irrespective of any electrical agency, to impress upon the air the needful vibrations to reproduce speech. Edison then devised a transmitter wherein the disk need not be metallic, but might be mica, and its vibrations were caused to operate upon a small block of carbon, which carbon was introduced in the circuit of a battery. It was thus found that the almost inappreciable variation in pressure due to the vibration of the disk was sufficient, for some not very well understood reason, to alter the conducting power of the carbon, and to cause varying currents to be transmitted along the line-wire to the Bell receiver at the opposite end.

At the present day the universal transmitting instrument for commercial purposes is the carbon transmitter of Edison, or some modification thereof. Professor Hughes' microphone was next alluded to, and it was stated how by its means the most minute sounds were rendered audible, and how, from the delicacy of the instrument, it is applicable to many scientific purposes. Edison's chalk receiver was subsequently explained. Prior to Edison's time, it had been known that the friction of certain surfaces varied with the electric current passing through them, notably under such circumstances the friction of the human tissue. Among other appropriate substances prepared chalk was one, and it was shown how Edison availed himself of this. By attaching a stem to the center of the disk, and pressing this stem by means of an adjustable pressure upon the periphery of a chalk cylinder, a current of electricity passed from the center of the cylinder through the stem. Upon the cylinder being turned by hand the friction on the stem caused it to move the center of the disk—its edge being fixed—to a definite position depending on the friction, and on the rigidity of the disk; but, on a variation in the current, the change produced thereby in the friction caused the stem either to be drawn in further or to yield to the elasticity of the disk and to allow it to be moved backward. In this manner vibrations were set up in the disk corresponding with the vibrations of the transmitter that had sent the varying electrical currents. As in the case of this receiver the power was derived, not from the electricity, but from the hand of the operator turning the chalk cylinder, very considerable loudness was obtained, so that the utterances of the receiver were audible in a large room.

Mr. Shelford Bidwell, having lent a photophone, that beautiful invention of Professor Graham Bell was explained. Mr. Bidwell showed how, by speaking to a disk, the front being a mirror on which a powerful light was directed, that light could be reflected on to a selenium cell, and as the disk vibrated under the influence of the voice the light playing on the selenium cell varied. Selenium was a material the conductivity of which changed with the amount of light upon it. It was therefore possible in this manner to cause a Bell receiver to speak, and reproduce the speech which had been uttered to the mirror disk. It was pointed out that in this manner there was no need of a wire connection between the transmitter and the receiver, the passage of a beam of light being all that was required.

Reference was then made to the various purposes to which the telephone might be put, and to the exchange system and the necessary apparatus for receiving the calls and making the connections between the different subscribers to the exchange. Among special uses, a very interesting one was shown—that of the application of telephony to the diver's helmet. Thanks to the kindness of the captain of H.M.S. Vernon and of Mr. Gorman, a helmet with the whole of the apparatus was exhibited. It was shown how the application of the telephone in no way introduced any complication, as the single wire needed was in the middle of the old call-rope, the return being made by the water itself. Thus, if the telephone went wrong, the diver was left without additional apparatus of any kind to encumber him, and yet with all the resources that he would have had in the absence of the telephone.

It was stated that the development of the telephone had been far more rapid in America than in England. As an instance it was mentioned that in the city of Washington, with a population of about 120,000 white persons, as many as 800 telephones were used. Then a return, circulated that very day by the United Telephone Company, was read, showing that on Feburary 28, in 1881, there were, independent of private lines, 845 subscribers to the London exchange; that on the same day in 1882 the number had increased to 1,505—or an addition of 660; and on Feburary 28 this year the number was 2,541, or an addition of 1,036; and that contemporaneously with these increases the use of the telephone by each subscriber had augmented, until it now reached more than 7½ calls per day for each subscriber, which—at a cost of £20 a year—represented only twopence a call; or, bearing in mind that each call involved a return message, it only amounted to one penny for the message sent each way.

The lecturer had the assistance of Mr. E. H. Johnson, who had been so much associated with Mr. Edison in carrying out many of his inventions, and who put into work both the phonograph and the chalk receiver.

ELECTRICITY IN GOLD MINING.

To the Editor of the Scientific American:

In your paper of the 10th inst. is an article entitled, "Electricity in Gold Mining," credited to *The Engineer*, which contains some statements so extravagantly varying from the practical results which are familiar to all mining men here that I ask your indulgence for calling attention to some of them.

The Engineer says that it takes about three ounces of gold to saturate seventy-five pounds of mercury. In treating our free milling ores here in the Black Hills of Dakota, mercury will absorb very nearly its own weight; the amalgam after a thorough squeezing will retort from forty to sixty per cent. of its gross weight. *The Engineer* also says that two or three drops of oil from a bearing will "sicken instantly" twenty or thirty pounds of mercury. It is a well known fact that oil or grease of any kind in any considerable quantities, passing into the battery of a stamp mill, will prevent amalgamation, the grease coating the particles of gold, and preventing the mercury from taking it up, also causing the powdered ore to cling together in small masses, and thus pass away without the water having action upon it, but it will certainly take a great many times two or three drops of oil to make any perceptible impression on an ordinary battery, such as is used in our stamp mills here. A battery of five stamps passes through about fifteen tons of quartz in twenty-four hours, and uses about a miner's inch of water, *i. e.*, a volume of water passing through a hole one inch square with a pressure or head of six inches. Oil being lighter than water has a constant tendency to rise to the surface; the gold and mercury, being among the heaviest metals, constantly settle. The ordinary battery for free gold ore has a table covered with copper plates galvanized by dressing it with mercury, sometimes with silver first, and always with mercury to catch the gold as it passes over the plates, and there are various devices in use below the plates to catch such gold as may pass over them without adhering, such as riffles, troughs of mercury, such as *The Engineer* describes, blankets, settling vats, etc., etc.; but what effect would two or three drops of oil have on such a volume of water and ore? Surely not much! Whatever damage the oil would do would commence in the battery, or wherever the grease struck the ore, and must be in considerable quantities to be perceived; and to do any hurt in the troughs of mercury would require more agitation than that caused by the thin sheet of water and ore pulp passing over the table.

The Engineer describes, or attempts to describe, what is known as the free milling process, but goes on to describe its application to the reduction of what are called refractory ores, that is, ores where the gold is mixed or alloyed with base metals and their compounds, so that mercury can not act to take it up; and cites a case of a mine where the gold quartz carries *no less* than forty-two ounces of gold per ton (*i. e.*, about $840 per ton), and yet "so foul" that it cannot be worked. I imagine that such a statement would cause the superintendent of Mr. Hill's reduction works in Colorado, or the Swansea people, in England, to smile broadly.

Among the most refractory ores known is what is called zinc blende silver ore. I have heard of samples carrying $90 of silver per ton, which could scarcely be worked at a profit by any known process; but even this, when carrying over $100 per ton, would leave a margin for smelting, and generally smelting costs from $20 to $30 per ton. When the author of *The Engineer* article speaks of gold ore carrying $840 per ton so foul that it cannot be worked at a profit, there must be a big mistake somewhere. Gold is the most indestructible of metals; it will endure a heat without perceptible diminution which will evaporate most other metals. Had the author of *The Engineer* article had a sample of his $840 ore assayed by some competent metallurgist, I think he would have found that it could be worked at a profit, and a very handsome profit too. A very simple smelting apparatus would reduce the metals in his ore to a few pounds, so that he could then ship his base bullion to any part of the world for rectification.

The free milling process as now in use here is as simple, about, as thrashing wheat. Even small custom mills work ore for one dollar and fifty cents per ton, and ore which will yield $3 per ton gross can be mined and milled at a profit. The author of *The Engineer* article seems to speak of 42 oz. of gold as being worth £126 Sterling; 42 oz. at $20 per ounce is $840, and £156 Sterling at $5 per pound equals $630. The difference between $840 and $630 would be considered by most men engaged in reducing such ores as more than ample pay for turning the ore into pure bullion. Again, the author speaks of ore, "which will carry, by laboratory analysis, 5 oz. or 6 oz. of gold to the ton, yet owing to the *sickening* of the mercury, the most that can be got out of it will be a couple of pennyweights perhaps, *hardly enough for working.*" Five oz. of gold are worth about $100, and six oz. about $120, and I will venture the statement that there is not a gold ore in the world so refractory but that it can be worked at a handsome profit, if it can be found in quantities carrying the amounts above named; with silver ores it would be more doubtful.

It is of course to be sincerely hoped that the author of the article in question has discovered some practical use for electricity in gold mining. I do not even offer an opinion on the subject, but if the whole subject is as full of holes as the introductory part of it, the final results will not meet the sanguine expectations of the inventor. I would in no way discourage experiment in this line, but an overcredulous public has been so often duped with mining schemes and inventions as to bring the business into much disrepute.

GEO. L. HOUGHTON.

Deadwood, D. T., April, 1883.

NOTE ON TERRESTRIAL RADIATION.*

By JOHN TYNDALL, F.R.S.

ON Hind Head, a fine moorland plateau, about three miles from Haslemere, with an elevation of 900 feet above the sea, I have recently erected a small iron hut, which forms not only a place of rest, but an extremely suitable station for meteorological observations. Here, since the beginning of last November, I have continued to record from time to time the temperature of the earth's surface as compared with that of the air above the surface. My object was to apply, if possible, the results which my experiments had established regarding the action of aqueous vapor upon radiant heat.

Two stout poles about 6 feet high were firmly fixed in the earth 8 feet asunder. From one pole to the other was stretched a string, from the center of which the air thermometer was suspended. Its bulb was 4 feet above the earth. The surface thermometer was placed upon a layer of cotton wool, on a spot cleared of heather, which thickly covered the rest of the ground. The outlook from the thermometers was free and extensive; with the exception of the iron hut just referred to, there was no house near, the hut being about 50 yards distant from the thermometers.

On November 11, at 5:45 P.M., these were placed in position, and observed from time to time afterward. Here are the results:

6 P.M.	Air 36° F.	Wool 26° F.
8:10 "	" 38	" 34
9:15 "	" 36	" 25

Air almost dead calm, sky clear, and stars shining.

November 12, the wind had veered to the east, and was rather strong. The thermometers, exposed at 5 P.M., yielded the following results:

5:15 P.M.	Air 38°	Wool 33°
5:45 "	" 38	" 34
6:15 "	" 38	" 35
9 "	" 39	" 36

During the first and last of these observations the sky was entirely overcast; during the other two a few stars were dimly visible.

On November 13, 25, and 26, observations were also made, but they presented nothing remarkable.

It was otherwise, however, on December 10. On the morning of that day the temperature was very low, snow a foot deep covered the heather, while there was a very light movement of the air from the northeast. Assuming aqueous vapor to play the part that I have ascribed to it, the conditions were exactly such as would entitle us on *à priori* grounds to expect a considerable waste of the earth's heat. At 8:5 A.M. the thermometers were placed in position, having left the hut at a common temperature of 35°. The cotton wool on which the surface thermometer was laid was of the same temperature. A single minute's exposure sufficed to establish a difference of 5° between the two thermometers. The following observations were then made:

8:10 A.M.	Air 29°	Wool 16°
8:15 "	" 29	" 12

Thus, in ten minutes, a difference of no less than 17° had established itself between the two thermometers.

Up to this time the sun was invisible; a dense, dark cloud, resting on the opposite ridge of Blackdown, virtually retarded his rising.

8:20 A.M.	Air 27°	Wool 12°
8:30 "	" 26	" 11
8:40 "	" 26	" 10
8:45 "	" 27	" 11
8:50 "	" 29	" 11

During the last two observations, the newly risen sun shone upon the air thermometer. As the day advanced, the difference between air and wool became gradually less. From 18° at 8:50 A.M., it had sunk at 9:25 to 15°, at 9:50 to 13°, while at 10:25, the sun being unclouded at the time, the difference was 11°; the air at that hour being 31° and the wool 20°.

In the celebrated experiments of Patrick Wilson, the greatest difference observed between a surface of snow and the air two feet above the snow was 16°; while the greatest difference noticed by Wells during his long continued observations fell short of this amount. Had Wilson employed swandown or cotton wool, and had he placed his thermometer four feet instead of two feet above the surface, his differ-

* A paper read before the Royal Society, Feb. 8, 1883.

ence would probably have surpassed mine, for his temperatures were much lower than those observed by me. There is, however, considerable similarity in the conditions under which we operated. Snow in both cases was on the ground, and with him, as with me, there was a slight movement of the air from the northeast. The great differences of temperature between earth and air, which both his observations and mine reveal, are due to a common cause, namely, the withdrawal of the check to terrestrial radiation which is imposed by the presence of aqueous vapor.

Let us now compare these results with others obtained at a time of extreme atmospheric serenity, when the air was almost a dead calm, and the sky without a cloud. At 3:30 P.M., January 16, the thermometers were placed in position, and observed afterward with the following results:

3:40 P.M.	Air 43°	Wool 37°
3:50 "	" 42	" 35
4 "	" 41	" 35
4:15 "	" 40	" 34
4:30 "	" 38	" 32
5 "	" 37	" 28
5:30 "	" 37	" 30
6 "	" 36	" 32

These observations, and especially the last of them, merit our attention There was no visible impediment to terrestrial radiation. The sky was extremely clear, the moon was shining; Orion, the Pleiades, Charles' Wain, including the small companion star at the bend of the shaft, the north star, and many others, were clearly visible. On no previous occasion during these observations had I seen the firmament purer; and still, under these favorable conditions, the difference between air and wool at 6 P.M. was only 4°, or less than one-fourth of that observed on the morning of the 10th of December.

We have here, I submit, a very striking illustration of the action of that invisible constituent of the atmosphere to the influence of which I drew attention more than twenty-two years ago. On the 10th of December the wind was light from the northeast, with a low temperature. On the 16th of January it was very light from the southwest, with a higher temperature. The one was a dry air, the other was a humid air; the latter, therefore, though of great optical transparency, proved competent to arrest the invisible heat of the earth.

The variations in the temperatures of the wool, recorded in the last column of figures, are, moreover, not without a cause. The advance of temperature from 28° at 5 P.M. to 32° at 6 P.M. is not to be accounted for by any visible change in the atmosphere, or by any alteration in the motion of the air. The advance was due to the intrusion at 6 P.M. of an invisible screen between the earth and firmament.

As the night advanced, the serenity of the air became, if possible, more perfect, and the observations were continued with the following results:

6:30 P.M.	Air 36°	Wool 31°
7 "	" 36	" 28
7:30 "	" 35½	" 28
8 "	" 35	" 26
8:30 "	" 34	" 25
9 "	" 35	" 27
10 "	" 35	" 28
10:30 "	" 35	" 29

After this last observation, my notes contain the remark, "Atmosphere exquisitely clear. From zenith to horizon, cloudless all round."

Here, again, the difference of 4° between the temperature of the wool at 8:30 P.M. and its temperature at 10:30 P.M. is not to be referred to any sensible change in the condition of the atmosphere.

The observations were continued on January 17, 23, 24, 24, 25, and 30; but I will confine myself to the results obtained on the evening of the day last mentioned. The thermometers were exposed at 6:45 P.M., and by aid of a lamp read off from time to time afterward.

7:15 P.M.	Air 32°	Wool 26°
8 "	" 31	" 26
9:30 "	" 31	" 27

During these observations the atmosphere was very serene. There was no moon, but the firmament was powdered with stars. The serenity, however, had been preceded by heavy rain, which doubtless had left the atmosphere charged with aqueous vapor. The movement of the air was from the southwest and light. Here again, with an atmosphere at least as clear as that on December 10, the difference between air and wool did not amount to one-fourth of that observed on the latter occasion.

The results obtained on February 3 were corroborative. The thermometers were exposed at 6:15 P.M.

7:15 P.M.	Air 34°	Wool 28°
8:25 "	" 34	" 30

Here again, the difference between air and wool is only 4°, although the sky was cloudless, and the stars were bright. The movement of the air was from the southwest and light.

On the forenoon of this day there had been a heavy and persistent rain storm Heavy rain and high wind also occurred on the night following. The serene interval during which the observations were made lay, therefore, between the two storms. Doubtless the gap was well filled with pure aqueous vapor.

Further observations were made in considerable numbers, but they need not here be dwelt upon, my object being to illustrate a principle rather than to add to the multitudinous records of meteorology. It will be sufficient to say, that with atmospheric conditions sensibly alike, the waste of heat from the earth varies from day to day; a result due to the action of a body which escapes the sense of vision. It is hardly necessary for me to repeat here my references to the observations of Leslie, Hennessey, and others, which revealed variations in the earth's emission for which the observers could not account. A close inspection of the observations of the late Principal Forbes on the Faulhorn proves, I think, that the action of aqueous vapor came there into play, and his detection of this action, while unacquainted with its cause, is, in my opinion, a cogent proof of the accuracy of his work as a meteorologist.

POSTSCRIPT.

In the *Philosophical Transactions* for 1882, part i., p. 348, I refer to certain experiments executed by Professor Soret, of Geneva. My friend has recently drawn my attention to a communication made by him to the French Association for the Advancement of Science, in 1872. It gives me great pleasure to cite here the conclusions at which he has arrived:

"The influence of humidity is shown by the whole of the observations; and it may be stated generally that, other circumstances being equal, the greater the tension of aqueous vapor, the less intense is the radiation.

"In winter, when the air is drier, the radiation is much more intense than in summer, for the same height of the sun above the horizon.

"On several occasions a more intense radiation has been observed in dry than in humid weather, although the atmosphere was incontestably purer and more transparent in the second case than in the first.

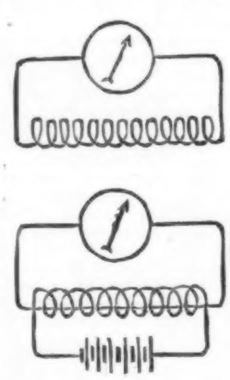
"The maximum intensity of radiation, particularly in the summer, corresponds habitually to days exceptionally cold and dry."

Such are the results of experiments executed by a most excellent observer on the radiation of the sun. They apply word for word to terrestrial radiation. They are in complete harmony with the results published by General Strachey in the *Philosophical Magazine* for 1866, while the experimental basis on which they rest was furnished several years earlier.

MAGNETISM.

Prof. A. E. Dolbear says:

If a galvanometer be placed between the terminals of a circuit of homogeneous iron wire, and heat be applied, no electrical effect will be observed; but if the structure of the iron is altered by alternate bending, or twisting to a helix, as shown in the sketch, and heat applied, then the galvanometer will indicate the presence of an electrical current in the wire. The professor used a circuit of homogeneous iron wire, and the application of heat produced no electrical current in the wire. A portion of the wire was surrounded by a helix, and connected with a battery; the current in these wires magnetized the circuit wire where it was surrounded by the helix; under these circumstances, the galvanometer



showed the presence of electricity in the main circuit, as it is well known that upon the application of heat to a circuit of unhomogeneous material a current is produced, and this experiment showed that a current was produced in the circuit, only when a portion was magnetized. These experiments prove that magnetism must be connected with some molecular change of the metal magnetized.

ENAMEL PHOTOGRAPHY.

We have before us, as we write, a charming specimen of enamel photography. It represents the sweet face of a dainty little lady of some fifteen summers, the half tones soft and translucent to a degree, while yet there is that brilliancy and smoothness, both in high lights and dark shadows, only seen in photo-enamels of a high order. This enamel, so pure and delicate that it recalls Lafon de Camarsac at his best, we saw created a few hours since, from first to last, under the skillful hands of Mr. A. L. Henderson. He demonstrated the whole story of its production, and that story we are now going to tell our readers. There is nothing new in the formulæ we print, nor in the manipulations; but as it is not reserved to many to see the production of a photo-enamel in its perfection by a master hand, we make no apology to set down here an account of enamel photography in practice.

Mr. Henderson does not employ the dusting-on method, but calls his *modus operandi* partly a substitution process, and partly a depositing process. He begins his work as we enter, for Mr. Henderson is a busy man, who estimates time at its proper value. This is a collodion dark room with yellow windows in which we stand, and therefore most agreeably lighted. There is a copying camera at hand, and as Mr. Henderson lifts one of the yellow windows, we see a negative is already in position for copying. A glass plate is coated with Mawson's collodion —the glass being simply polished, and not prepared in any way—and put into a silver bath; the latter is somewhat weak, being made up at twenty-two grains of silver nitrate to the ounce, and it is fully iodized. The aim is to produce a clear transparency: "What is best suited for a lantern transparency is best suited for an enamel, I always say," is Mr. Henderson's remark, as he presently puts his sensitized plate into the dark slide.

In nine cases out of ten a vignetted transparency is required for enamel photography, and obviously the vignetting must be done with extreme delicacy. To effect this vignetting in the camera, Mr. Henderson makes use of the pendulum vignette arrangement, which, though it has been repeatedly described, is not so well known as it should be, that its capabilities may more perfectly understood. A is the transparency, the pendulum or rather pendulum bob, in which a small oval orifice exists, through which the photographic lens can peep at the transparency. If you look on the focusing glass of the camera, now the pendulum is still, you see the portrait as in a cut-out mount; that is to say, the bust of the portrait in a sharply-cut oval. But set the pendulum swinging—not, of course, side to side, but so that it oscillates to and fro between you and the negative, coming first toward you, and then receding toward the negative—and you observe a marked difference in the image on the focusing screen. The bust then is in an oval which is always altering in size, constantly decreasing or increasing in magnitude; and obviously, if this occurs during the exposure of the plate, a very perfect vignette is produced. The pendulum is easily constructed, and, as it affords valuable assistance in making all sorts of transfers and enlargements, those who engage in such work should give it a trial. Mr. Henderson's pendulum is some 40 inches long, and he tells us he frequently times an exposure by counting its beats; as most of our readers are aware, the beat of a pendulum of some 39 inches is reckoned about one second.

Our collodion plate has an exposure of two minutes, one of the yellow windows of the laboratory being lifted halfway up to allow of the transparency or negative being illuminated. The developer contains three grains of iron to the ounce, and is used with a restrainer consisting of a little citric acid and alum. The development, therefore, is rather slow. No intensification follows, care being taken, indeed, not to get the half-tones too marked, as they otherwise get exaggerated in the after manipulations.

Our thin collodion transparency has next the margins removed by simply passing the fingers round the plate, and scraping the collodion off. To loosen the film, it may be laid for a time in acidulated water (sulphuric acid four ounces, water one quart), for, as we have said, the glass receives no preparation to facilitate the separation of the film. It is now put into a dark brown solution of iodine, made by dissolving odine crystals in iodide of potassium and water. The silver image is in this way converted into iodide of silver, and rapidly assumes a yellowish tinge. A few minutes only are necessary for the conversion—the film by this time is generally free of the glass, but this is kept underneath, as a convenient means of support—and then, after careful washing, it goes into the depositing bath. This last consists of iodine, bichloride of platinum, lead, and tin; and, according to Mr. Henderson, no better formula can be given than that mentioned in his specification. Here it is:

Bichloride of platinum	5 parts.
Bichloride of tin (or its compounds)	30 "
Iodine, to saturation.	
Hydrochloric acid	960 "
Silicate of potash	20 "
Acetate of lead	40 "
Water	8,000 "

It is necessary, while the film is in the platinum bath, that the solution should always be in motion, otherwise the deposition is not uniform. Mr. Henderson has an ordinary bottle-jack, from which is suspended a shelf, and upon this the platinum bath, containing the film, is placed. The shelf revolves, and thus the solution is never at rest.

The film image now undergoes great change. It becomes dark and sooty in appearance. It appears so very much overdone and so opaque that only firm faith in the process prevents you from throwing it away. The time required for depositing is rather undefined, for the process sometimes lasts for hours; but it may be accomplished in a few minutes under favorable conditions, if the liquid is not cold; and Mr. Henderson, in fact, is, at a pinch, capable of getting through the whole process of enameling, from taking the transparency down to firing the plate, in half an hour.

We now come to the firing. Mr. Henderson uses a most serviceable little muffle furnace, constructed for him by Messrs. Nicole, Nielsen & Co., of Soho Square, at a cost, we believe, of ten or twelve pounds. It is heated by Bunsen gas burners so readily that, between twenty minutes after being lit, the inside is of a cherry red, and ready for use. In front of the furnace is a tray which serves to rest enamels upon, to warm them before entry into the furnace, or for withdrawing them for a moment, for examination, during the process of firing. An oval enamel plate is selected, polished with a little putty powder to free it from any traces of oxide, and then rubbed with an alkaline solution (caustic potash dissolved in water) to remove any grease or finger-marks. To avoid air-bubbles between film and enamel is of the greatest importance, and therefore the application of the one upon the other is done under water. The concave enamel plate is immersed sideways, so that it cannot act as a diving-bell, and retain air-bells underneath; and then the sooty film, attached to the under side of a glass plate, is put under the water too, taking care that the film rests face upward upon the enamel. In this, as in fact, in every other manipulation in the process, practiced skill is necessary, and hands new to the work are scarcely likely to perform perfect work at the first trial.

The film being neatly and closely fitted over the enamel—a penknife is used for lifting the enamel, to avoid fingering—this is withdrawn from the water, and here the position of the image may be readjusted by skillful fingers; indeed, very skillful fingers are necessary to adjust cleanly and nicely, for nowhere on the face of the image must there be a touch. The enamel is a very unpromising thing to look at now; it is ten times as dark as it should be, and of a dirty, opaque black. It is drained, and then put on the tray in front of the furnace to dry and warm. Gradually it turns to a brown, and loses much of its sooty blackness. In five minutes, or even less, it is brown all over, and ready for firing. Too rapid heating, however, induces blisters. Mr. Henderson has in his hand an iron spatula; he opens the furnace door, and takes out by means of this handy tool a porcelain plaque, of which there are several heating, and puts this hot biscuit-looking slab on the tray in front of the furnace. Then the spatula is slipped under the enamel, and the latter put upon the plaque, where it gets rapidly heated. A few seconds elapse, and the enamel by this time being very hot, the spatula is slipped under it once more, and it is conveyed into the furnace. A pot of cold water close at hand serves to cool the spatula from time to time, and thus prevent an untoward accident to the manipulator.

Gradually the image begins to assume a glaze at the edges. In two or three minutes the high lights are as shining as the enamel plate was before the image was placed upon it, but the dark shadows still remain dull. Mr. Henderson puts his handy spatula under the enamel, and brings it out of his furnace for our inspection. It is of a lovely primrose color, but the dark shadows in the hair are still dull; consequently it is remitted to the furnace for a few minutes longer, and now, when it is withdrawn, although there is still the bright primrose tint, the whole surface is glossy in the extreme.

The enamel is finished. It is permitted to cool, and the yellowness rapidly gives place to a brilliant white. The dark, opaque brown shadows have all disappeared, and in their place are delicate and translucent half-tones and glossy blacks. In five minutes the enamel is perfectly cold, and Mr. Henderson presents it to us as a memento of our visit. But he quickly takes it back again; in the background are two minute black specks—dust that has dropped from the furnace. These are ruthlessly dug out with a penknife, retouched in fusible pigment by an assistant, and the enamel once more committed to the oven. In two or

three minutes the enamel has been again fused, and before long it is once more in our hands, without a sign of any imperfection.

"Many think that success depends upon timing the sojourn of an enamel in the furnace to a second," says Mr. Henderson; and to show this is not the case, our friend selects a portrait by his side—it is one of a series of family pictures that Mr. Henderson is executing for the King of Siam—and, putting it into the furnace, shuts the door upon it for five minutes. At the end of this time, copper and enamel were so soft that the spatula could cut them in two, but still the image, except that its tint is slightly reddened by the operation, undergoes no change. "No, the great enemy to enamel photography is dust, and therefore I take care to disturb it as little as possible," says Mr. Henderson.

Putty powder is a wonderful aid in enamel photography. Not only is it invaluable in polishing an enamel surface, but it permits you to modify your image. If this appears too dark, you may withdraw it from the furnace when only half fired, and when the more delicate tints are glazed, but the heavy shadows still unburnt. Then, a little friction with putty powder will reduce the darker shadows considerably, after which the enamel goes into the furnace once more, and the firing is completed. Spoilt enamels are simply cleaned off with fluoric acid, and the plates used once more. —*Photographic News.*

PHOTO PRINTING AND PHOTO PLATES.*

By far the larger portion of commercial photography in the United States is devoted to photo-mechanical reproduction, and this may be divided into three branches: 1st. That class depending upon the copperplate press for multiplication of copies, of which the photo-gravure may be regarded as an excellent illustration. 2d. The class which is reproduced lithographically, depending upon the repellent and absorbent chemical qualities of a sensitized film for the result. The Albertype is the best example of this class. 3d. The numerous typographic class, which, although indirectly covering a larger range or field than any of the previous classes, is valued more from a practical than an artistic point of view. The zincotype belongs to this order.

Of the first class I shall simply say that the photo-gravure is carried on in the United States under various names, the methods, however, being essentially the same as on this side of the water, except that perhaps we do not produce such good work.

In the second class we find many important establishments, the Albertype being produced with singular beauty: the heliotype and various modifications of both these methods are in a flourishing condition. One of these methods is worthy of note. A negative is taken (we will say) of a rose, leaving out all the color but the red; a second is taken of the green, and a third of the shades and shadows. These are reproduced by the Albertype method, and printed in register with each other in tints as near as possible the original color. The result is a soft, pleasing, and lifelike print, depending, however, greatly upon the chemical manipulation of the operator, and also upon the proper choice of colors by the printer.

In the third or typographic class, to which I now refer, two methods are commonly in vogue—first, the zincotype class, which simply depends on photography for the image and upon the addition of a corrodent for the relief; and, second, those which, like the gelatinotype, depend for relief upon either the swelling or dissolution of a sensitized film of gelatine or gum. In the zincotype and the swelled gelatinotype the negative is of the ordinary opaque description, such as is made use of in photo-lithography, and is usually intensified with lead or copper. In the case of the dissolved gelatinotype the negative that is used must be a reversible film, which is made in this way: The glass is very thinly albumenized, and, after the negative is obtained and dried, it is treated to a coat of india-rubber dissolved in sulphuric ether; this is, when dry, coated with collodion. The glass is then immersed in water or dilute acetic acid, when the impressed film comes away quite easily, is quite strong, and can thus be readily reversed; and after use, instead of being scraped into the cleaning trough, it is taken off its support and put away for further reference.

Zincotype, as commonly practiced, consists in transferring an inky image to a suitable piece of metal by the well-known photolithographic method. This transfer is dusted with resin flour, which serves the double purpose of further protecting it from the encroachment of the corrodent, and also of protecting the sides of the slightly-etched lines from undermining from the same cause. This is done after the first application of the acid by slightly warming the plate, causing the resin to melt and run down on the sides of the lines, which are thus shielded from the subsequent applications of the corroding agent. I may say that the zincotype has given way to the gelatinotype almost universally; and I will close with the three most usual forms of the latter process, the first and second depending on the expansion of portions of the film, and the third upon its melting or dissolution.

With the swelled gelatinotype No. 1, an ordinary glass is coated with the sensitized solution of gelatine, giving a film the thickness of a very thin card. This is printed under a negative, which is carefully masked to prevent overprinting in the shadows. When printed the plate is immersed in a solution of tannin or alum, where it remains till the unprinted portions are sufficiently swelled. The printed film, of course, retaining its normal condition and thickness, assumes the appearance of small but regular depressions all over the surface of the plate. A wax cast is taken from this, which in turn gives the matrix for the stereotype.

In the second swelled gelatine method any thin sheet metal is used instead of glass; but the metal must be protected from the action of the bichromate, otherwise the plate will soon become corroded and useless. The plate, after printing in a screwback frame, is placed in a chrome alum bath, and when sufficiently raised is cast direct in plaster and electrotyped, which makes the process somewhat shorter than the foregoing one.

The last gelatine method or dissolving process is done in this way: The melted solution is poured into large plate-glass trays with a raised lip or edge. These trays have previously been flowed with a thin solution of beeswax in ether to prevent the film, which is nearly one-sixteenth of an inch in thickness, from adhering to them. They are then leveled up in the drier, and when chilled are placed face downward until dry, when the large sheets of gelatine are easily stripped from the trays. With a pair of shears a piece of the size wanted is cut off these sheets and placed under the negative in an ordinary frame. After a short exposure it is taken into the dark room and temporarily fastened to a glass with shellac; an ordinary brush, such as is used by silversmiths, is then immersed in warm water and rubbed over its surface and the unprinted portions dissolve at once, leaving the printed parts intact. When sufficiently dissolved, the plate is placed in alcohol for a few seconds to free it from water, and is then dried, when it is ready for the electrotyper at once. A word upon the intractability of gelatine films of appreciable thickness may not be out of place. The addition of glycerine hardly helps matters much, as in the swelled gelatine process we find that, when sufficient glycerine has been added to prevent the cracking of the film, the entire film after soaking becomes flaccid and easily displaced.

The peculiar way in which gelatine films will crack off the plates—flying into numberless pieces, frequently taking the glass with them—is annoying, to say the least; and I find that even here the phenomenon is not unknown. I have seen a piece of plate glass ⅜ in. thick coated with a film hardly thicker than this paper, which, when subjected to a change of temperature, cracked with a sound like tearing strong cloth. Upon examination the surface of the glass in places was found torn out to the depth of ⅛ in., and adhering to the gelatine fragments which strewed the floor. A mere accident led to the discovery of a remedy. An experimenter having mixed up his gelatine to soak, was suddenly called away. At the end of three days he returned, and was assailed by the odor that greeted him from his gelatine, which had taken advantage of his absence to decompose thoroughly. He was about to throw it away, when the idea struck him that perhaps it might act differently from ordinary gelatine; so he cooked it, made up his plates, and, after testing them in every possible way, found they would neither crack off, swell off, bubble, frill nor act in any of the inconvenient ways with which gelatine workers used to be so familiar, and perhaps are not entirely free from yet.

* Extracted from a communication of the Edinburgh Photographic Society, by J. P. Suverkrop.

METHODS OF INTENSIFYING AND REDUCING GELATINE PLATES.

By E. H. Farmer.

The Polytechnic Method with Silver.—A solution is prepared as follows:

No. 1.

Silver nitrate	1	ounce.
Water (dist.)	12	ounces.

No. 2.

Potassium bromide	½	ounce.
Water	2	ounces.

No. 3.

Thiosulphate of soda (hypo.)	2	ounces.
Water	6	"

Add No. 2 to 1, and after washing the precipitated bromide thoroughly by decantation, dissolve with agitation in No. 3. The muddy liquid thus obtained is either filtered perfectly clear or placed aside for a day, and the clear solution siphoned off; it is then made up to sixteen ounces with water and kept for use. To intensify a plate wash roughly after fixing, and, taking it on a pneumatic holder, flood with the following mixture:

Pyro. (preserved in sulphite)	4 grains.
Water	2 ounces.
Silver solution	1 drachm.

to which is added immediately before use about half a drachm of dilute (1 to 8) ammonia. If the silver show no tendency to reduction add more ammonia, and if it be thrown down immediately use less. With a little experience a peculiar browning of the liquid shows when sufficient ammonia is added.

Rock the plate and apply fresh solution as the density gradually increases. If not sufficiently dense, and the solution be muddy, rinse the plate and use fresh, and, finally, place it for a short time in the fixing bath and wash; or immerse the washed plate in the silver solution, and leave it there for five minutes. Take out, drain, and flood with an ordinary oxalate developer, when the image will rapidly increase in density. Rinse the plate and place in the fixing bath as before. If the plate only require slightly intensifying, dilute the silver solution more or less as desired. *Note.*—Plates which in ordinary development show signs of fog setting in can be successfully treated thus: *Immediately* a trace of fog appears, wash and fix the plate, again wash, and treat with the above intensifier, when the required detail and density can readily be obtained.

REDUCTION OF DENSITY.

There are three principal methods of reducing density: 1. The image may be changed in color, so as to be more transparent to actinic light. 2. It can be partly converted into some compound, which can be dissolved out in hypo. or other solvent. 3. The gelatine film can be reduced in thickness by solution or mechanical means.

Mr. W. E. Debenham's Method with Ozone Bleach.—Two solutions are required:

No. 1.

Chrome alum	1 ounce.
Water	1 pint.

No. 2.

Ozone bleach.

The plate is immersed in a solution composed of half an ounce of each of these in five ounces of water, and then in the hypo. bath. To reduce locally a stronger solution is poured in a stream on the part desired, the operation being repeated, if necessary.

Method with Chloride of Lime or with Eau de Javelle (hypochlorite of Potash).—For the first a saturated solution of chloride of lime is prepared, and for the second:

* Chloride of lime	2	ounces.
Carbonate of potash	4	"
Water	40	"

The lime is mixed with thirty ounces of the water, and the carbonate dissolved in the other ten ounces. The solutions are mixed, boiled, and filtered. Either of these are diluted and the plate immersed until the required reduction is produced; it is then passed through the fixing bath and washed. In these cases a double action occurs, part of film being dissolved off, and a portion of the silver being converted into chloride, which is removed in the fixing bath.

Method with Ferric Chloride.—A solution is prepared with—

Ferric chloride	1 drachm.
Water	4 ounces.

The plate is immersed in this, which converts the silver into silver chloride, and on washing and immersing in the hypo. bath this is dissolved out.

Other Methods.—There are various other methods extant for reducing density—one or two, requiring only a single solution, I have found answer very well:

No. 1.

Copper sulphate	½	ounce.
Ammonia, sufficient.		
Water	1	pint.

The quantity of ammonia is such as to redissolve the precipitate first formed on adding it to the copper sulphate.

No. 2.

Potassium ferricyanide (red prussiate of potash)	1	ounce.
Water	1	pint.

A few drops of ether should be added to an ounce of the hypo. bath diluted with four ounces of water, and the plate immersed until the requisite reduction is obtained and washed. In the first case silver sulphate, and in the second silver ferrocyanide, are formed, and immediately dissolved out by the hypo.—*Br. Jour. of Photo.*

* Instructions in Photography.

ON BISULPHIDE OF CARBON.*

By L. H. Friedburg, Ph.D.

Several years ago I published some notes on bisulphide of carbon,† to which I shall add to day a few more observations. Then and there I showed how to clean the bisulphide by means of fuming nitric acid, and that the vapors of nitrous acid, of nitrogen dioxide, of sulphurous acid, etc., were taken up and invariably retained by the bisulphide. Dry bisulphide of carbon serves as a very good conveyance for the reaction of such gases and vapors in a dry state on each other and on other substances. The only disagreeable feature in this regard is that carbon bisulphide in most cases also enters the reaction, forming very undesirable products, and sometimes only such sulphur containing products are formed in any notable quantity. The following reactions are the only three I wish to mention, as they may prove germs for further investigations:

1. Bisulphide of carbon charged with the vapors of nitrogen dioxide and then mixed with pure benzol, forms among other products large, broad crystals of dinitro-benzol, melting at + 84° C. These crystals are formed after standing a considerable time, and after the partial evaporation of the mixed liquids at summer heat.

2. I think that great interest is attached to the reaction of the aforesaid liquids in direct sunlight. The brown vapors begin to disappear without escaping from the narrow neck of the very large flask in which such experiments take place, and in proportion as they disappear small white crystals begin to cover the sides of the flask within. This covering principally takes place above the edge of the liquid on the bare glass. The crystals could not be analyzed because they decomposed when brought in contact with air, yielding then NO_2 and benzol. It is not entirely out of the way to suppose that in this case addition products formed, analogous to benzol hexachloride ($C_6H_6Cl_6$) so that the white crystals in this case might be either $C_6H_6(NO_2)_6$ or $C_6H_6(NO_3)_6$, which of course needs further investigation.

3. A very pretty reaction takes place when bisulphide of carbon charged with dry sulphurous acid gas, and the same medium charged with nitrogen dioxide (which was not free from nitrous acid) are brought together. This reaction might be used as a lecture experiment. Keeping the vessels cool and dry (I generally use a spacious beaker), white crystals very readily form in considerable quantity, which, in fact, are nothing but lead chamber crystals. This reaction treated analytically may some day throw new light on the formation and composition of lead chamber crystals.

The bisulphide of carbon cleaned by means of fuming nitric acid is the only chemically pure I came across, and I therefore proceeded to determine its specific gravity as well as boiling point, though without finding any differences from former determinations.

The specific gravity at + 15·2° C. is 1.266, and the boiling point is + 47·4° C. at 0·760 m. pressure.

The pure bisulphide shows materially no other so-called physical properties than those known heretofore.

Finally, I want to state, that in treating raw bisulphide of carbon, coming from the retorts of manufacture, with fuming nitric acid, I could invariably detect mononitrobenzol in the residue of evaporation, which leads me to believe that among the numerous products formed in the red hot retorts, particularly if the charcoal was not dry enough, there is also benzol.

2. The purifying influence of a non colored and inodorous fat, for instance such as the oil of African palm kernels,‡ good as it is for the bisulphide of carbon, becomes a nuisance when this latter is used as a means of extraction of the former. I advise, therefore, from long experience, all those who extract fats (particularly if it is for soap manufacturing) by means of CS_2 never to use an excess of this latter, and never to let a new mixture of oil and bisulphide run into the still in which oil already freed from bisulphide is retained. This latter will else be rendered impure.

SODA IN MILK.

By W. Bachmeyer.

The milk to be examined must have an alkaline reaction, which will always be the case in recent milk sophisticated with soda. The cream is removed and portions of 15 c. c. are placed in flat capsules. To the first are added 3 c. c., to the second 5 c. c., and to the third 10 c. c. of a moderately strong solution of tannin, and the samples are then allowed to stand eight to twelve hours in a cool place. The author's experiments show that a proportion of soda of 0·3 grm. per liter betrays itself by a deep, dirty greenish blue color; samples free from soda, after standing from twelve to twenty hours, show at most a dull gray. The test is confirmed by the addition of a few drops of dilute acetic acid, which produce in the greenish samples a transitory green coloration.

* A paper read before the American Chemical Society, November, 1882.

† Berichte d. d. ch. Ges., viii., 1616.

‡ Ibid.

YELLOWSTONE NATIONAL PARK GEYSER WATERS.

By HENRY LEFFMANN, M.D.

THE specimens from which the following analyses were made were collected by Dr. A. C. Peale, in 1878. Most of the geysers and hot springs are silicious, and produce deposits which vary from hyalite to chalcedony, according to age. In most of the waters examined the silica is in the free condition, and has been so expressed. All the results are given in grains to the Imperial gallon.

1. *Pearl Geyser.*

Calcium sulphate	1·400
Sodium sulphate	1·890
Sodium chloride	61·390
Silica	7·840
	72·520

At the bottom of the bottle containing this water was a quantity of gelatinous matter looking very much like white of egg. Under the microscope it was entirely structureless, and by heat it dried up to a white opaque mass. Only a small quantity was available for analysis. This was collected on a filter, washed well with distilled water, and then allowed to remain for several weeks in a closed vessel with strong sulphuric acid. It shrank to about one-tenth its volume and became white. It was weighed, heated to redness, weighed again, and then the silica determined by fusion as usual. The results were:

		Per cent.
Weight before heating	0·163 gramme.	
Weight after heating	0·155 gramme =	water 4·9
Silica	0·129 gramme =	" 79·1
Traces of Al_2O_3, Fe_2O_3, and CaO.		

The deposit is probably gelatinous silica mixed with some impurities.

2. *Jug Spring.*

Calcium carbonate	0·791
Sodium carbonate	49·140
Sodium sulphate	2·121
Sodium chloride	31·570
Silica	14·560
	98·182

3. *Opal Spring.*—This is not a geyser, but a spring having the temperature of 90° Fahr. The water is opalescent; its appearance is exactly like that which is produced by adding an alcoholic solution of resin to a large volume of water. The opalescence remains for months, even though the water is kept perfectly quiet. On evaporating the water it gelatinizes markedly before it becomes entirely dry.

Sodium chloride	72·180
Calcium sulphate	3·220
Calcium chloride	4·060
Silica	53·760
	143·220

4. *Deposit from Bronze Spring, Shoshone Geyser Basin.*—This deposit is in convoluted layers with bronze-colored surfaces. The powder is fawn-colored. Hardness, 5·5.

Silica	83·1
Iron oxide and alumina	1·2
Organic matter and water	13·6

On heating the powder in the drying oven it loses five per cent.; a high heat causes it to turn gray, and give out a distinct odor of nitrogenous organic matter. The iron oxide and alumina appear to be in union with the organic matter.—*Am. Jour. Sci.*

ON HÆMATOXYLEINE AND HÆMATEINE.

By E. ERDMANN and G. SCHULTZ.

THE hard crystalline deposit adhering to vats in which extract of logwood had been kept was ground up with water to a paste and extracted in large bottles with much ether. The ethereal extract was drawn off when clear; the ether distilled off, and the sirupy extract mixed with hot water. The hæmatoxyleine crystallizes out and may be purified by recrystallization. From dilute solutions are obtained columnar, often hollow, needles containing 3 aq.; but from more concentrated solutions rhombic tables with 1 aq. From the mother-liquors, on concentration, there are sometimes deposited shining leaflets of hæmateine—a proof that this product exists preformed in the raw material. The authors saw no reason to question Gerhardt's formula, $C_{16}H_{14}O_6$. They consider that it contains only five hydroxyl-groups. The authors find that the yield and purity of hæmateine are greatly influenced by the duration of the process. It is best to pour the ammoniacal solution of hæmatoxyleine into roomy, shallow glass capsules, so as to afford the largest possible surface; to keep up a constant small excess of ammonia by the occasional addition of a few drops, and to take from time to time small samples and mix them with acetic acid in a test-tube. As soon as a precipitate appears, immediately, or after a short time, and on boiling is converted into crystalline scales, the experiment is stopped, the whole product is heated to boiling in a flask, and neutralized with acetic acid. The composition of hæmateine is expressed by $C_{16}H_{12}O_6$. The authors, in opposition to Benedict, find no trace of nitrogen in hæmateine. Hæmateine is scarcely soluble in boiling water. It dissolves freely in hydrochloric acid, and crystallizes out in small, dark red needles. In sulphuric acid it dissolves also to a red liquid, which, on mixture with water, deposits a red powder, not stable if filtered off. It redissolves on the application of heat, unless an excess of water is present, and on cooling crystallizes in needles. Sulphurous acid, and especially alkaline bisulphites, quickly dissolve hæmateine in great quantity, forming an almost colorless solution. There is, however, here no reduction to hæmatoxyleine. There are formed very soluble addition products; that with sulphurous acid is partially decomposed by boiling, while that with sodium bisulphite is decomposed on heating with an acid, and deposits hæmateine. The authors could not by any method succeed in reproducing hæmatoxyleine from *this* hæmateine. Reim, however, obtained from hæmatoxyleine another oxidation product, which he, indeed, considers identical with Erdmann's hæmateine, but which, though possessing the same percentage composition, is totally different in its behavior. Reim's derivative appears in the form of brownish-red needles, which dissolve in boiling water much more freely than Erdmann's hæmateine. The solution in sulphuric acid does not give a red precipitate when mixed with water. Above all, Reim's product is at once reduced to hæmatoxyleine on boiling with sulphurous acid. Meyer's observation that hæmatoxyleine, when submitted to dry distillation, yields a mixture of resorcine and pyrogallic acid was decidedly confirmed. The two compounds may be approximately separated by extraction with boiling benzol, in which pyrogallic acid is more readily soluble.

[Continued from SUPPLEMENT No. 381, page 6083.]

MALARIA.

By JAMES H. SALISBURY, A.M., M.D.

PRIZE ESSAY OF THE ALBANY MEDICAL COLLEGE ALUMNI ASSOCIATION, FEB., 1882.

V.

PLATE V., and Z, Plate III., represent the abnormal bodies found in the urine of patients laboring under intermittent fever. In some cases the plants appear as seen at A, and in others as seen at E; in others as seen at B, C, D, and G; and in still others as represented at K, P, Q, R, U, and V, Plate V., and at Z, Plate III., and sometimes nothing is found in the urine but the minute oblong cells or spores of these plants, which are seen scattered at the right of the figure, Z, Plate III.

The peculiar bodies having the appearance of being made up of acicular crystals radiating from a single point, and represented at W, Q, and R, Plate V., are sometimes found in ague urine. These bodies are identical with those found on the bogs among the developing gemiasmas, which are represented at D and J, J, J, Plate III.

In the urine of a patient aged 13, with the tertian type of ague, were found abundantly the bodies represented at Q, R, S, T, U, V, Plate V. He had his first paroxysm September 15. The urine examined was voided September 21, during the subsidence of the fever of the fourth paroxysm. He had taken no medicine. Urine of high color, quite free from sediment, containing many minute flocs floating through it. These flocs were examined a few hours after the urine was voided, and were found to be composed of the bodies above referred to. Several flocs like that represented at R were left between the slides of the microscope over night, floating in urine.

In the morning the urine was quite evaporated, and growing from these flocks were the variously sized pedunculated sacs, S, S, Plate V. On applying moisture the elongating of the peduncle was so rapid that they could be seen to extend in length and the cells to recede. At length the cells would become disengaged from the foot stalks, become spherical and granulated, as represented at T, Plate V. Some of these would become nucleated, while others would remain transparent. They gradually enlarged, and finally each cell formed a new plant, as represented at U and V, Plate V. Here is a mode of plant formation resembling strikingly the development of some protozoa, as the amœba, also one of the early stages of development in the cell products of the spleen. In the flocs were also noticed the radiating bodies which are represented at Q and W, Plate V. These are identical with the peculiar bodies, A, J, J, J, Plate III., found among developing ague plants. The peculiar growth seen at X, Plate V., was frequently met with in the urine of ague when the patients were exposed to the continued cause, and had been for some time afflicted with the disease, and whose systems were debilitated.

It occurred in small, flat, white, curd like scales or masses, scarcely visible to the unaided eye, floating in the urine. These masses, as is seen in the figure, are composed of closely packed, short fibers or threads, running at right angles to the flat, scale like mass. Among the threads or fibers are masses of spores, and on the upper ends of the fibers are minute cells, which have the appearance of being spermatia. These masses resemble a growth found often growing among

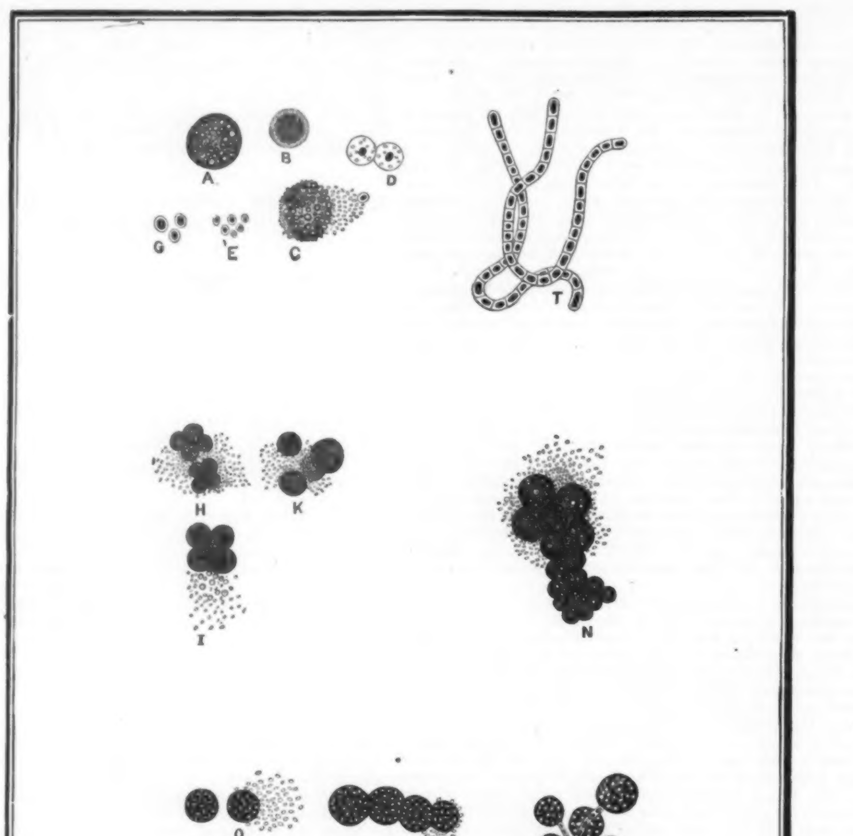


PLATE IV.—Plants producing malarias of a congestive type, such as are developed on the rich calcareous soils back of Vicksburg, Yazoo, Nashville, Louisville, Cincinnati; also found in the expectoration of persons exposed to the night exhalations from the soil of ague localities—A, B, C, D, E, G, H, I, K, M, N, and T. At C the minute contents of a plant are being discharged which at E and G are more highly magnified. H and I, Gemiasma verdans. K, Gemiasma rubra. L, Confervoid alga. M, Fungus spore? N, Gemiasma plumba. O, P, Q, Gemiasma rubra found in the urine of patients suffering from chronic congestive intermittents. At Q is also a parasitic penicillium.

PLANTS PRODUCING MALARIAS OF A CONGESTIVE TYPE, FOUND IN SPUTA AND URINE.

Occasionally a severe, continued case is found where all the forms are met with in abundance in the same patient. A, B, C, D, and E, Plate V., are ague palmellæ that have been developed in the bladder. There are but few cases that I have met with where the brown spore cases, as seen at D and C, were found. Where the plants are developed in the system they are very frail and transparent, readily yielding to pressure, and very friable. They seldom have much color till after being exposed to light.

Occasionally flocs of these plants with fungoid filaments vegetating from them are met with in the urine of ague patients, as seen at Z, Plate III., and at K, Plate V. These flocs in the freshly voided urine are white, minute, and scarcely visible to the unaided eye. They are light and float in the urine, and would be overlooked save by the careful observer, as they are slow to be deposited with any sediment that may subside by the urine standing or otherwise. The fungoid filaments vegetating from these flocs belong to the genus Sphærotheca, and are the same plants as are represented farther advanced at O and L, L, L, Plate V.

ague plants on boggy grounds. One of these is represented at I, Plate III. The growth is, so far as my observations have gone, uniformly present in the urine of typhoid fever, and may have something to do with the cause of this disease. The cells represented at P, Plate V., are sometimes met with in ague urine, and appear to belong also to the palmellæ, resembling somewhat the plants, A and A', Plate III.

The cells, F, Plate V., are also palmelloid, and are frequently met with in ague urine. They are developed upon wet, low bogs, when drying off during the warm summer months. The cells, I, H, and G, Plate V., are embryonal plants and are constantly present in the urine, perspiration, and blood of intermittent fever. The more severe the case, and the longer its standing, and the greater the systemic derangement, the more abundant generally are these bodies, which most writers call bacteria. In every sample of urine all the abnormal bodies were carefully figured and described as they were met with, with statements as to their frequency, etc. This mode of inquiry involved the labor of many hundred drawings, which made the investigation slow and laborious. This was done to avoid trusting at all to the memory for the details of so extended a series of observations, and to have accurate representations of the bodies all before me at once, after the examinations were completed. This involved a great amount of repetition in the drawings, but afforded valuable material for general conclusions. It would be interesting to give the detailed results, in order to exhibit the constancy of the presence, in some form, of the ague plant. This, however, would involve a far too great expense in engraving, and too extended, detailed description for a paper of this kind. I have therefore so condensed and generalized as to give those bodies only which are either constant or frequent accompaniments of the disease. There was a variety of other abnormal bodies present, but these varied in different cases and were by no means constant. In all congestive types of ague, I have found in the urine the reddish plants represented at O, P, and G, Plate IV.

As corroborative evidence that these peculiar palmellæ are the true source of ague, as I observed it, I refer to the preceding description. I may also add that I have never met with these plants abundantly in any locality but that intermittent fever was already present as an accompaniment,

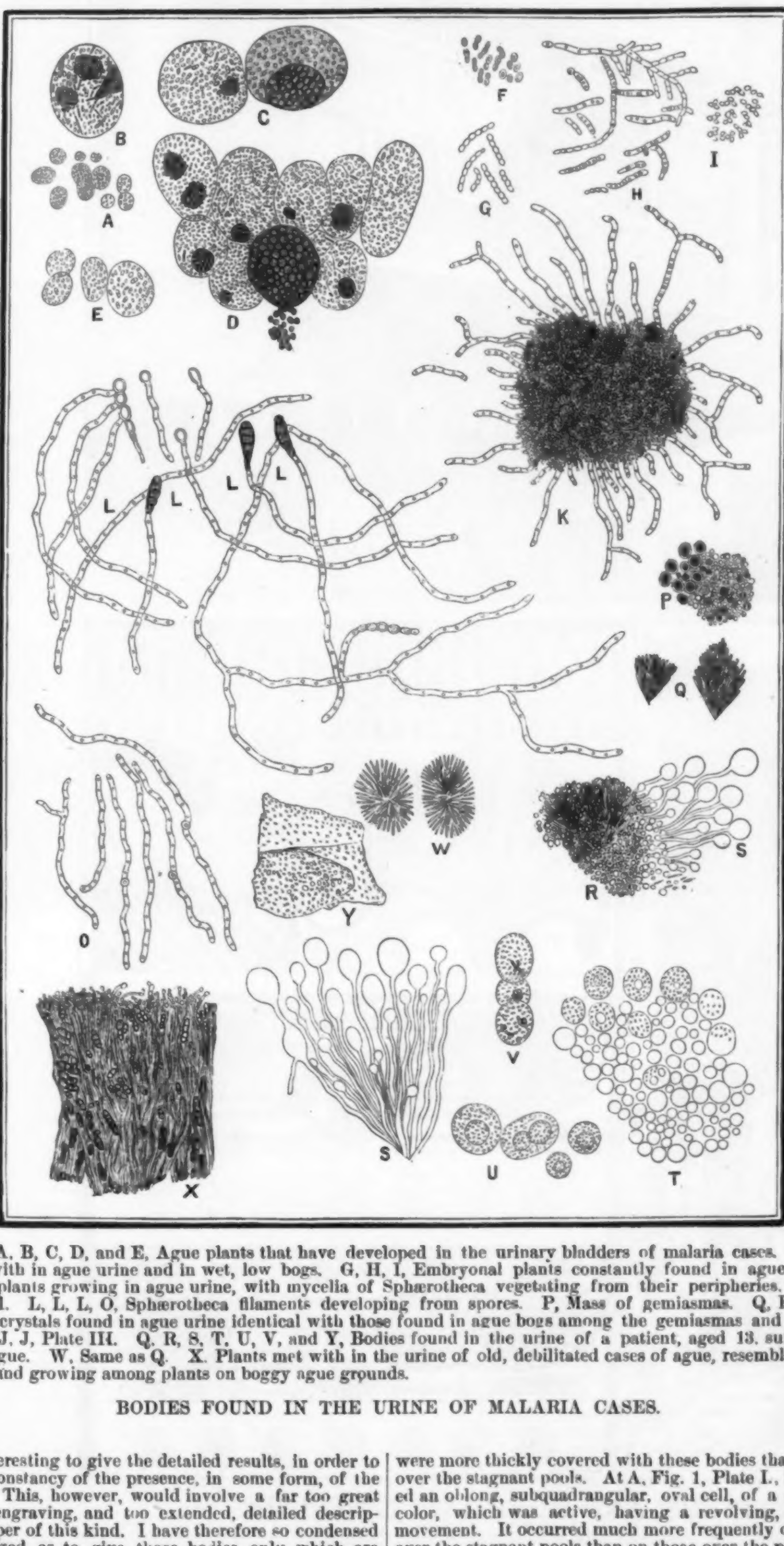


PLATE V.—A, B, C, D, and E, Ague plants that have developed in the urinary bladders of malaria cases. F, Palmellæ met with in ague urine and in wet, low bogs. G, H, I, Embryonal plants constantly found in ague urine. K, Mass of plants growing in ague urine, with mycelia of Sphærotheca vegetating from their peripheries, same as Z, Plate III. L, L, L, O, Sphærotheca filaments developing from spores. P, Mass of gemiasmas. Q, R, Bodies of acicular crystals found in ague urine identical with those found in ague bogs among the gemiasmas and represented at D, J, J, J, Plate III. Q, R, S, T, U, V, and Y, Bodies found in the urine of a patient, aged 13, suffering with tertian ague. W, Same as Q. X. Plants met with in the urine of old, debilitated cases of ague, resembling growths often found growing among plants on boggy ague grounds.

BODIES FOUND IN THE URINE OF MALARIA CASES.

or soon made its appearance. Sometimes the mere digging of a well or a few rods of ditch through new, humid, black, or rich ground, or the spading or the turning up of a few feet of new, rich, humid soil, is sufficient to generate locally the disease, during the usually dry, warm months of July, August, and September. Those in the immediate vicinity of the palmellæ vegetation are the first to be affected; especially if they are situated on the side toward which the wind blows. This was beautifully illustrated in the cases previously described.

Microscopic Examinations.—Active and inactive cells and bodies that are elevated and suspended in the night vapors from stagnant pools and bogs partially submerged.

These observations were made during the months of June, July, August, and September, in the ague districts of central Ohio. The exhalations from bogs partially submerged and from stagnant pools were collected for examination by suspending glass plates (16 by 22 inches) in a horizontal position, about one foot above the surface. Each plate was supported by four pegs, one at each corner. They were placed in position at dusk, and secured in the morning before sunrise. Invariably the under surface of the plates was found covered thickly with large drops of water, formed by the condensation of the rising vapors. In this condensed water occurred the bodies represented from A to P, Fig. 1, Plate I.

The plates suspended over the partially submerged bogs were more thickly covered with these bodies than the plates over the stagnant pools. At A, Fig. 1, Plate I., is represented an oblong, subquadrangular, oval cell, of a dark brown color, which was active, having a revolving, progressive movement. It occurred much more frequently on the plates over the stagnant pools than on those over the partially submerged bogs. They are probably algoid cells in the zoosporoid stage of development. At B, D, F, G, and H, Fig. 1, Plate I., are represented active zoosporoid cells, having a zigzag, oscillatory, or undulatory progressive movement, rotating or rolling from side to side on their longest axis as they progress. This motion, during the last stages of their active existence, resolves itself into a rhythmical, pulsatory movement, during which the cells have a tendency to assume a spherical form. These are very abundant, both on the plates suspended over the partially submerged bogs and stagnant pools. At C, Fig. 1, Plate I., are active bodies composed of minute cells, joined end to end. They have a squirming, progressive movement. Similar bodies are found in all fermenting and decaying matters, and are known as vibriones. They appear to be confervoid. At E, Fig. 1, Plate I., are transparent cells with cilia and without any cell contents. They are seldom met with on the plates. At I, Fig. 1, Plate I., are represented large granular appearing cells filled with small ones. They are quite numerous on the plates over the bogs, and sometimes appear to have a pulsating or jerking motion, but are generally stationary. At K, Fig. 1, Plate I., are large inactive cells containing nuclei. They occur on the plates over the bogs. At M, Fig. 1, Plate I., are represented algoid cells, attached to a filament, and adhering to the same filament are a couple of diatoms. These with other diatoms are quite frequently met with on the plates over the stagnant pools. O, a diatom. N, a portion of an algoid filament. At P, Fig. 1, Plate I., are represented the minute oblong cells occurring so constantly in the expectoration of the constant malarious cause of ague. They occur only on the plates over the boggy grounds. These are cells from peculiar, minute palmelloid plants growing upon the soil of desiccating bogs, and the dry, freshly exposed, new soil of humid, rich, low grounds.

The mode of collecting these bodies, elevated and suspended in the heavy night vapors, has been previously described. They are represented from a to w, Fig. 2, Plate I. Those represented at O, R, K, K', V, S, T, and U, Fig. 2, Plate I., are universally met with in the heavy, humid, cool exhalations rising both from desiccating, peaty bogs and from the recently exposed, drying soil of rich, humid, low ground. Whether the fresh new soil be exposed to the desiccating influence of the sun by plowing, excavations, or by other means, the result is the same. The other bodies represented under Fig. 2, Plate I., are confined mostly to the plates suspended over desiccated, peaty bogs, those that have been partially covered with water during a portion of the year. In these exhalations there are no active or zoosporoid cells found, unless there happens to be a small pool of water under the suspended plate. The cells, C and C', Fig. 2, Plate I., were always found in abundance attached to the plates where they were suspended over desiccating peaty bogs. They are sporoid cells from large species of palmellæ growing abundantly upon such bogs, and described in figure farther on. With the cell, C, were met the masses of spores represented at M, M', D, D', and B, same figure and plate. These are from a species of Sphærotheca which develops abundantly in the larger species of palmellæ. Their color is a beautiful brownish yellow. N, N', F, and I, Fig. 2, Plate I., are young palmelloid plants. E, and E', Fig. 2, Plate I., represent cells of palmellæ that occur frequently on the plates suspended over the peaty bogs. Their color is usually a light orange yellow. G, and L, Fig. 2, Plate I., are greenish cells, having granular contents, often occurring aggregated in the substance of palmelloid plants, in the hymeneal tissue, near their inferior surface. V and W, Fig. 2, Plate I., are greenish granular bodies, having externally a tuberculated appearance, and filled with minute oval or spherical cells. These are frequently met with on the plates suspended over the bogs.

Of all the bodies found adhering to the plates suspended over the low, humid grounds of ague districts, those represented at O, R, K, K', V, S, T, and U, Fig. 2, Plate I., are the most constant. These are universally present. They belong to a minute and peculiar species of palmellæ that rapidly develops on desiccating, peaty soil, and upon freshly exposed, rich soil from new, humid, low grounds. They are constant accompaniments of ague in all ague districts, and are found invariably in the morning expectoration of all such as are exposed to the heavy, humid, night exhalations of ague localities.

Low calcareous lands in malarious regions produce several other species of palmellæ, one of which has a pink or brick-dust color, another is green, while a third is brownish green. This last species is more rare than others, and produces glistening, metallic, plumbous patches on the surface of humid calcareous soil where the new earth has been recently exposed.

These several species are represented at A, B, C, D, E, G, H, I, K, and N, Plate IV., and at A, A', B, B', C, C', D, Plate III. They are the plants which produce intermittent fever of a congestive type. This congestive form of ague has a much stronger tendency to suppress and otherwise derange the functions of elimination and assimilation than those that are developed upon non-calcareous soils. These latter are white or slightly tinged with green and yellow, and are represented on the Plates I. and II., and produce the ordinary mild forms of ague—those which generally yield quite readily to the tonic and anti-fermentative or cryptogamic influence of quinine.

Bodies found in the morning expectoration of all such as are exposed to the night exhalations from the desiccating soils of peaty bogs and humid, low grounds of ague localities.

By walking for half an hour or even for a less time over an ague bog or over a calcareous soil producing malarial palmellæ, during the evening or early morning, the mucous lining of the fauces and bronchi become thickly covered with the bodies elevated and suspended in the heavy night vapors of such localities. These are readily dislodged with the expectoration. They were found in the experiments on myself and many others to be essentially the same as the bodies that become attached to the under side of the glass plates suspended during the night over ague soils and bogs, and which are represented under Fig. 2, Plate I., and at A, B, C, D, E, G, H, I, K, and N, Plate IV. By microscopic examination of the condensed vapors upon glass plates suspended upon both low and higher levels, during the same night, and examination of the expectoration of persons occupying the same planes during the same time, it was determined that there was a correspondence always on the same level and locality between the bodies inhaled and those adhering to glass plates; and further, that the bodies elevated from the low, humid, ague lands did not usually rise to exceed thirty-five feet above such levels, and never above the upper line of the visible vapors; that up to the summit level of these vapors the atmosphere was always cool and damp, while above it was much warmer and drier. This was found to be so marked that in ascending elevated ground during the evening the line of demarcation between the ague vapors and the superincumbent dry air was readily indicated by the difference in humidity and temperature.

In examining the expectoration of persons upon levels above the reach of ague, almost always were found the spores (single or in masses) and broken filaments of the Sphærotheca pyrus (M, M', B, and D, Fig. 2, Plate I.). These occur abundantly upon fruit trees and decaying fruit at all elevations. There will always be also found algoid cells from stagnant waters similar to those represented at Fig. 1,

Plate I. The peculiar cells of the palmellæ (O, R, K, K', V, S, P, and U, Fig. 2, Plate I.) are not found save in the atmospheric zone of ague.

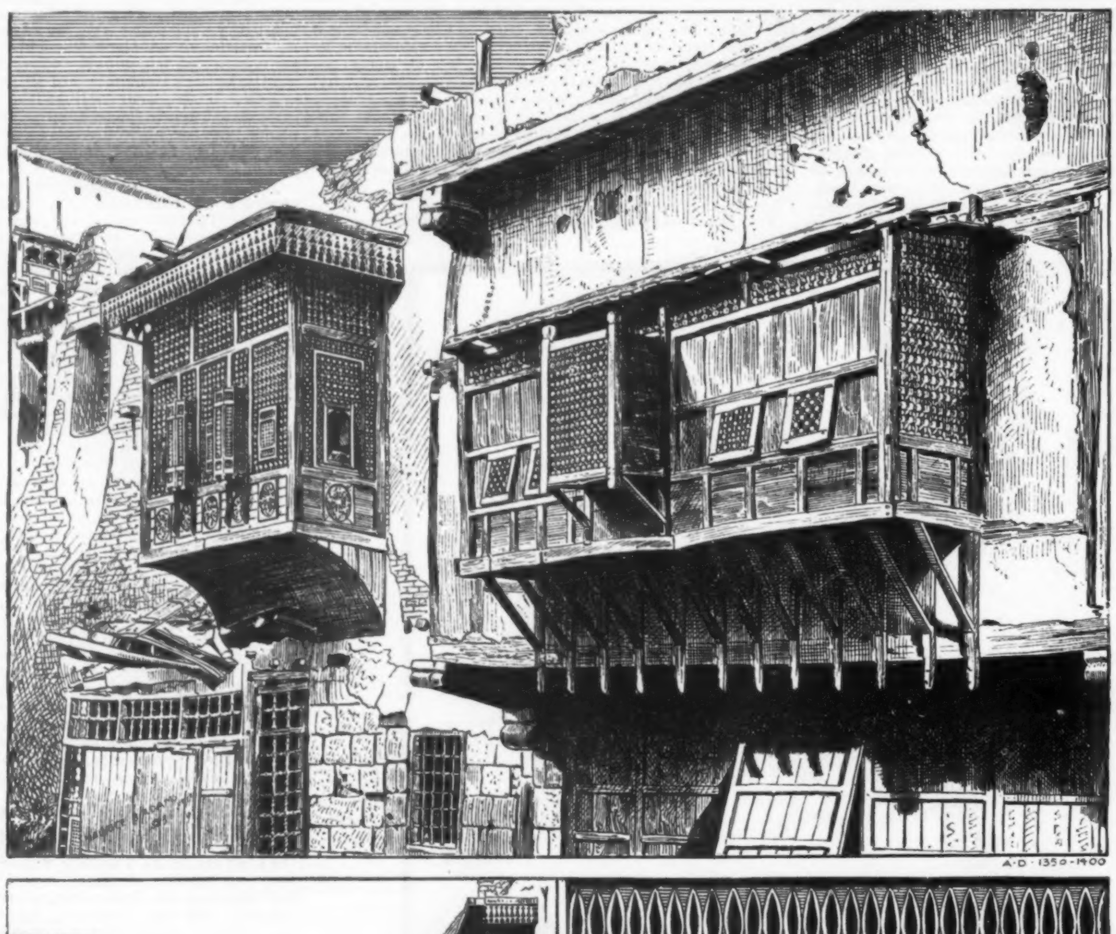
[*To be continued.*]

CAIRENE MESHREBIYEHS AND EGYPTIAN TAPESTRY.

CAIRO is typically and intensely the most Asiatic city in the world, although strictly speaking it is in Africa. For the study of Mohammedan races, their habits and their character, no place, except perhaps Damascus, offers so many facilities, while for the beauties of mediæval art in Egypt no town can compare with Cairene resources and remains. The natives here, as in the greater part of the country, call themselves Arabs, except the Copts. They talk Arabic, and are of the religion of the Arabian prophet Mr. W. J. Loftie, in his "Ride in Egypt" (Macmillan & Co., London) very graphically describes the present condition of these down trodden people, who still remain the servants of servants, toilers who cannot differ very much from the people of whom Herodotus says, truly or falsely, that a hundred thousand of them at a time were forced by Cheops to build his pyramid.

As Egypt was one of the first conquests of Mohammed's disciples, one of the earliest seats of the great caliphs, and long the center of Arab civilization, Cairo has more features of purely Arab type than Constantinople, or indeed any other Oriental city of its size, either in Asia or Africa. The Mohammedan at home therefore is best found in the old parts of Cairo, in the narrow picturesque streets, where scenes of unique interest will be found, and specimens of the most artistic work of the best period of the middle ages will be seen. Seldom wider than Paternoster Row, the streets twist and break round with sudden projections and overhanging stories in the most inconvenient fashion, at once affording a striking contrast to the lath and plaster modern quarter of the town, where half-French looking villas line the wide, well watered roads, leading in every direction to the trumpery buildings known as "Palaces of the Khedive."

Neglected and uncared for, the true art character of the older parts of the town still remains, notwithstanding all the tyranny of the Turks, which has not sufficed to alter the indelible beauty to be found there. Mr. Loftie thus peoples one of such thoroughfares as we have herewith drawn: "Here a long string of groaning camels, led by a Bedouin in a white capote, carries loads of green clover or long fagots of sugar canes. There half a dozen blue gowned women squat idly in the middle of the roadway. A brown skinned boy walks about with no clothing on his long, lean limbs, or a lady smothered in voluminous draperies rides by on a donkey, her face covered with a transparent white veil, and her knees nearly as high as her chin. A bullock cart with small wheels, which creak horribly at every turn, goes past with its cargo of treacle jars. Hundreds of donkey boys lie in wait for a fare, myriads of half clothed children play lazily in the gutters, turbaned Arabs smoke long pipes and converse energetically at the corners, and every now and then a pair of running footmen, in white shirts and wide, short trousers, shout to clear the way, for a carriage in which, behind half drawn blinds, some fine lady of the viceregal harem takes the air. She is accompanied perhaps by a little boy in European dress, and by a governess or nurse whose bonnet and French costume contrast strangely with the veiled figure opposite. A still greater contrast is offered by the appearance of the women who stand by as the carriage passes, whose babies are carried astride on the shoulder, or sometimes in the basket so carefully balanced on the head. The baskets hardly differ from those depicted on the walls of the ancient tombs, and probably the baby, entirely naked and its eyes full of black flies, is much like what its ancestors were in the days of Moses."



CAIRENE MESHREBIYEHS AND EGYPTIAN TAPESTRIES.

The houses are solidly constructed of coursed masonry, which for the most part is plastered, and the same finish is given to the oversailing stories between shaped or plain timber framing. The skyline of horizontal masses is considerably varied by the crumbling and more or less dilapidated condition into which the facades generally have fallen; it is also further broken by the quaintly projecting and richly canopied meshrebiyehs or latticed verandas, with which most of the principal upper stories of the houses were furnished. These delicately traceried jalousies or windows have lattices within lattices, and frequently on every side enable the persons within to obtain a clear view of the street without discovering themselves to public gaze. The drawings which we publish show some good examples of these, both in detail and in general effect.

Much of this old Arabian woodwork is in excellent condition, though dating nearly some five hundred years back; neither the hard native wood nor the native workmanship showing any considerable traces of wear, although in most instances it has not either been painted or gilt. Messrs. H. & J. Cooper, of Great Pulteney Street, W., have on view just now some screen and traceried lattice work of this kind from a mediæval Egyptian house in Cairo, and their extremely interesting collection furnishes an exceedingly good idea of the characteristics of such a dwelling. The miniature oriels or windows without, and the many sided lacquered recesses for lamps within, are evident witnesses to the delicate good taste exemplified in old Arabian work, while its technical handicraft is thoroughly artistic, without being in the least mechanical. Little turned baluster-like pieces cross and recross, intersecting in an almost endless variety of patterns, and these again are elaborated by a secondary series of interlacings, sometimes in geometric forms, and at others in the shape of Arabic letter characters. The beauty and archæological interest of these buildings appear to have but little charm for modern taste in Cairo, where the authorities neglect their rarest monuments in the most senseless manner, while devoting misdirected energy and vast sums of money in erecting structures whose only merit seems to lie in the fact that from their shoddy construction they cannot last long.

The mosque in the citadel may be mentioned as a typical example of the way in which Cairene public works are carried out. The walls are lined with slabs of alabaster for about twenty feet from the ground, and above that height are painted and grained in imitation. Immediately below this monstrous monument of Turkish taste, adds Mr. Loftie, is the Mosque of Sultan Hassan, an edifice contemporary with our own Salisbury Cathedral, and worthy of careful study by every lover of simplicity and beauty in architecture; and here, while countless sums have been laid out on a French Alhambra kind of mosque close by, the whole building is going to destruction from neglect: its exquisite fretwork of precious inlays dropping from the walls, the roof of the central kiosque stripped off in great patches, the beautiful Syrian lamps, so much praised in guide-books, all gone, and the vane of the graceful minaret bowing to its fall. Yet it may be safely predicted that something of Sultan Hassan's building will remain long after every palace of the Khedive has disappeared.

ANCIENT EGYPTIAN TAPESTRY.

The fragment of ancient Egyptian tapestry is from the funeral tent of Queen Isi-em-Kheb of the dynasty of the high priests of Amen, whose chief temple was at Karnac. She was mother in law to the Shishak who besieged and took Jerusalem three or four years after the death of Solomon, B.C. 980. She seems to have died young, and it is therefore calculated by Mr. Villiers Stuart, M.P., in his elaborate work on this subject, that about twenty years should be allowed between these two events, which would make this specimen of needlework only a century later than the Trojan war. Since this funeral pall was executed the kingdoms of Israel and Judah have come and gone; the Greek Empire has come and gone, the Roman Empire, the Macedonian, the Assyrian, the Persian Empires, all have passed away, followed by endless mediæval dynasties and many mediæval kingdoms, while this piece of patchwork, wrought with multitudinous morsels of gazelle leather, has lain undisturbed in the silent vault from which it has now been brought nearly in its pristine brightness of hue to show what manner of tapestry was in fashion twenty-nine centuries ago. Its purpose was to cover as a canopy the shrine of the funeral boat on its way to its final destination. The canopy consists of a central panel six feet wide and nine feet long, divided into two equal sections. One is covered with pink and yellow rosettes on a blue ground, the other displays six vultures, each surmounted by a hieroglyphic text and divided from its neighbor by a row of pink rosettes on a yellow ground. Of these vultures we give two specimens in relative position. At either side is a flap divided from the central section by four bands of color—blue, red, yellow, and green—and further ornamented with a row of spearhead border pattern, a portion of which is reproduced in the illustration. Below this comes a row of panels containing various emblematical devices, and below that again is a chessboard pattern of pink and green squares, bordered at bottom with a broad belt of pink. The entire pall measures twenty-two feet six inches in length and nineteen feet six inches in width, and covers a space of two hundred and one square feet of leather. The colorings are subdued and harmonious, and are faithfully reproduced in Mr. Stuart's reduced facsimile diagram.—*Building News.*

RESCUE FROM HEARD ISLAND, NEAR KERGUELEN.

WE have received from Lieutenant-Colonel H. Robley, Sutherland and Argyll Highlanders, the sketch of a late rescue, by the U. S. ship Marion, eight guns, Captain Terry, of a crew cast away on Heard Island, a desolate rock in lat. 53° 20′ S., long. 73° E., distant thousands of miles from any other land than Kerguelen.

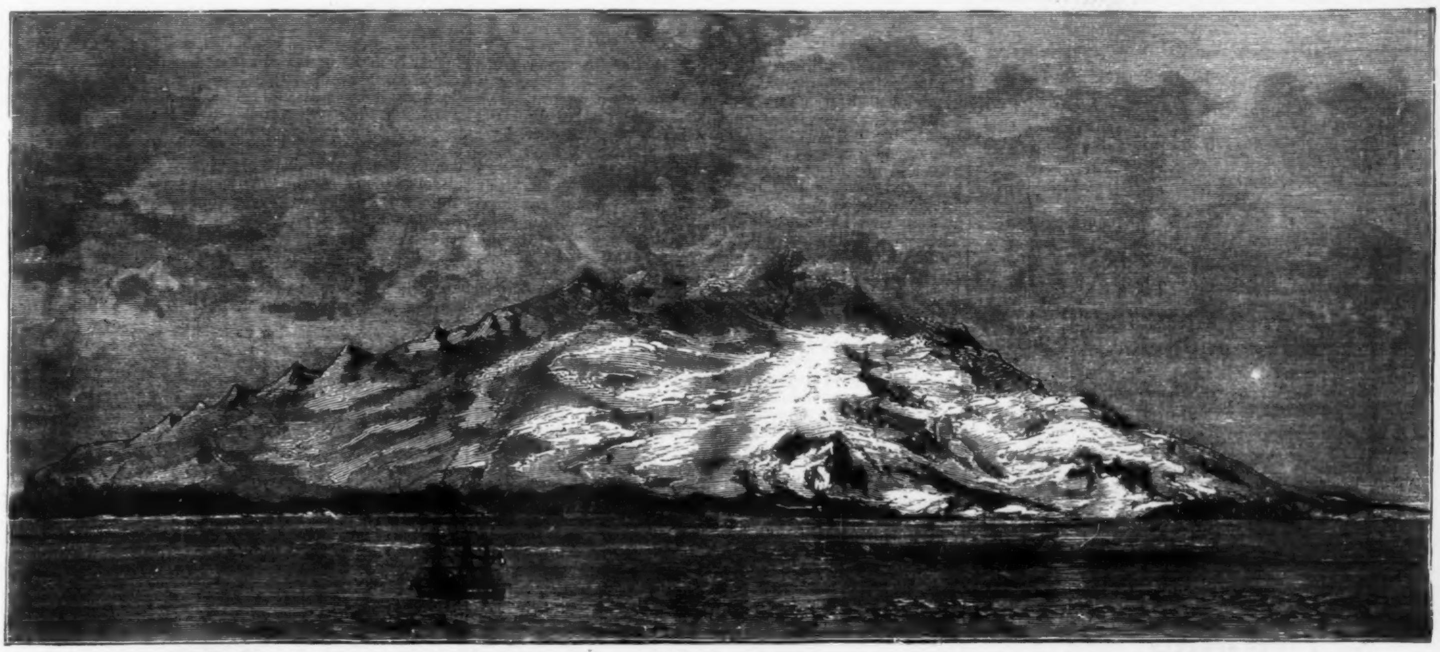
The bark Trinity having been missing some time, the Marion left Monte Video under orders to search for her, and had the fortune of discovering her crew, who, notwithstanding incredible hardships for fifteen months, were alive with the exception of two, though destitute of clothing and proper food. The Trinity had left for her cruise in June, 1880, in quest of sea-elephants—an animal resembling the walrus, and valuable for oil. She took at Cape de Verde nineteen natives, which with her crew made thirty-five souls. At Kerguelen Island she landed spare spars and provisions for her return voyage, and then continued to Heard Island, 275 miles S.E. Anchoring in Corinthian Bay, an exposed inlet at the northwest, four men with proper appliances for taking sea-elephant, and some months' provisions, were left. Twenty miles distant to Spit Bay a house was to have been erected for headquarters during the stay on the island. This bay, however, is merely a bight formed by black lava dust jutting into the sea. It affords poor shelter; and, the weather being bad, landing was out of the question. A gale sprang up, and the position of the ship was critical. Impossible to put to sea, the cable was slipped, and the ship had to be beached, fortunately with the entire crew safe, and a few articles of clothing and provisions; many stores were thrown overboard to drift ashore. Owing to extreme cold it was impossible to work, and the castaways took shelter in some deserted huts left behind by remote visitors. The same night the wind and tide floated the Trinity, and she drifted to pieces in the outer bar; so in like manner were all the floating stores lost. The castaways found themselves left with a few months' provisions and such clothing as they were in, little suited to the climate in which they were now to live for a year and more. Their prospect of discovery was indeed discouraging.

Heard Island is but little known to navigators, having been discovered thirty years ago by mere accident. No one had been there for four years, and then it was Captain Williams, of the Trinity, himself. A companion sealer was hoped for, but even then not till their absence created uneasiness from its duration. The castaways were doubtful of their ability to hold out so long. The stock of provisions was carefully husbanded; and, with the help of pen guins, sea-elephant meat, sea-fowls' eggs, and wild cabbage, which grew in a few sheltered spots, for fifteen months they managed to exist. Water was good, or melted snow; for fuel and cooking, the fat of the sea-elephant. Food was most unsavory; in fact, nothing short of starvation made its use possible. Notwithstanding the most rigid economy, the ship's provisions soon gave out—even after minute rations, such as a few crumbs, which might have been held in the palm of the hand. Several of the crew used the coffee as tobacco, smoking and chewing it instead of the usual way. So carefully were these stores kept that, when the Marion arrived, a few morsels were left, which, however, were ravenously devoured by the castaways when convinced that delivery was at hand. Deplorable were their clothes and repairs; one man had the soles of his boots made out of the remains of a handsaw; an old sail had been of the greatest use. Nevertheless, the castaways suffered extremely, and how they managed to exist is a mystery. The carpenter and a seaman were frozen to death in a glacier when in search of food.

Heard Island is a rock about thirty miles in length, and rises to a height of 7,000 feet, the peak being named Mount Emperor William. The island is nearly inaccessible; only two points allow of landing. It is covered with perpetual snow, except at a few spots on the beach; and in fact is but one of a system of glaciers extending from the mountain side into the ocean. Most of these break off from time to time at the water's edge, and, floating away as icebergs, leave perpendicular precipices of solid ice, in some cases several hundred feet in height, presenting a magnificent appearance. The uncovered spots are mere patches of black lava dust, and are very unsightly. Until lately Mount Emperor William was supposed to be an extinct volcano, but during their imprisonment the crew of the Trinity observed at least three eruptions, while smoke was of common occurrence. A clear day is a rarity in this dreary spot; no worse climate could be imagined than what prevails here. Heavy masses of black cloud and vapor hang over like a pall, and sudden and violent squalls prevail, frequently coming from several points of the compass in a few minutes, and of constant occurrence. It is probable that Heard Island will not be revisited for many years, as the sea-elephants have been nearly exterminated.

The Marion brought the castaways to Cape Town and refitted there after her rescue, and left about the middle of April, Captain S.W. Terry and his officers being most popular.

The sketch and description were afforded to our artist from notes taken on the spot of this rescue from this glacial island near the South Pole.—*London Graphic.*



THE RESCUE OF A CASTAWAY CREW FROM HEARD ISLAND, NEAR KERGUELEN.

SCIENCE AGAINST DARKNESS.

A STAGE ALLEGORY.

IT is not often that engineering science is depicted on the stage, but at the Eden Theater in Paris just now it is presented in an amusing "ballet in twelve tableaux," entitled "Excelsior," which, has for its theme a prolonged struggle between the powers of darkness and light, the former being represented by a Mephistophelian personage named L'Obscurantisme, and the latter by a charming lady in white satin and gold, named La Lumiere. The first scene, says *The Engineer*, opens with a struggle between the two, which is ended by Lumiere breaking by a sudden effort the fetters which have bound her, and the "march of progress" commences. In a succeeding tableau is a beautiful landscape with a broad river. Boatmen and peasants are dancing, and all is joy, when suddenly the demon appears, and announces that a new boat invented by a certain Denis Papin, and propelled by fire, is approaching, and that, unless restrained, it will render their strong arms useless. The boat appears with smoke issuing from a mysterious funnel, and the angry boatmen rush upon it and destroy it with axes. Papin mourns its loss, but Mlle. Lumiere comforts him by a glimpse into the future, showing him in a grand tableau the harbor of New York, with large ferry steamers with working beam engines passing under the Brooklyn Suspension Bridge, over which, with an audacity which a merely mundane engineer might envy, railway trains are rapidly passing, an equal disregard of facts being shown in a background of lofty mountains. M. Obscurantisme has, however, been busy elsewhere, and now has his malignant eye on Volta, who is seen seated in his laboratory "inventing the electric pile." The wealth of books and apparatus is peculiarly displeasing to the demon, who attempts to destroy them, but Volta, with a pitying smile of superiority, makes the sparks fly, and knocks him head over heels with an electric shock, and Lumiere, chasing him from the scene, reveals to the delighted philosopher the future of his invention in a tableau of the Washington Telegraph Office with a hundred messenger boys (ballet girls) in gay uniforms rushing in all directions with dispatches.

The scene again changes, and shows an African desert. A caravan is passing across the plain, pyramids and the sphinx in the background. Brigands attack the caravan; the simoon with its hurricane of sand envelops the combatants, who appear to die of thirst, to the great delight of the demon, who gloats over their misery. But Lumiere is equal to the occasion, and by a stroke of her wand produces a magnificent tableau of Ismailia and the Suez Canal, the blue waters of the latter supporting large steamships, and its banks embellished with green trees. As an appropriate incident, with which doubtless our merchant captains on their way to India are familiar, a grand dance by two hundred

ladies of the corps de ballet is given on the banks of the canal, in honor of "the immortal Lesseps," with much display of tricolor flags.

The pantomine continues, for not a word is spoken, and all depends upon the scenery and acting, assisted by the explanations on the play-bill. Obscurantisme, baffled on the surface of the globe, attempts to hinder the progress of science in the gloomy recesses below, and finds a specially favorable opportunity in the works of the Mont Cenis Tunnel. This scene is well depicted, the somber vault, the huge rocks, and the silent but industrous miners. Pick and shovel are at work, and very inefficient they appear, but one can hardly expect percussion rock-drills on the stage, and dynamite would be out of place. The demon has cast his baneful glance upon the work, and has discomfited the engineers, for they are evidently at fault. Either their dials have betrayed them or their levels are wrong, for they show signs of despair, wring their hands, weep upon each other's shoulders, and display other appropriate action. The gracious Lady Lumiere appears opportunely, drives back the demon, sheds her light upon the theodolites, and the engineers are restored to their wonted equanimity. Then a sudden pause, all listen breathlessly to distinct sounds; the foreign miners are approaching, the points of foreign pickaxes are seen to pierce the wall of rock, and with a grand crash the huge stones fall asunder, and the junction is effected. The workmen mingle, the Italian and French engineers embrace, kiss each other copiously after the manner of engineers, and the triumph is complete. And then the ballet. Never before was there such a scene in a railway tunnel—but it is not the time for criticism.

It is needless to add that Obscurantisme can no longer maintain the unequal combat, but finally disappears, and a last grand tableau displays the Temple of Civilization with Progress and Concord in the foreground, and ballet dancing all around.

The Eden Theater, wherein the play above described is being acted, has only been opened for a few months, and is hardly yet known to Englishmen. Situated in the Rue Auber, close to the new Opera House and the Grand Hotel, the site in so central a part of Paris cost an enormous sum, the total outlay for land and building being stated at ten million francs. The architecture is described as in the Hindoo style, the somewhat bizarre ornamentation being a repetition of that in a theater by the same architect in Brussels.

SIDE SHOW SCIENCE.

The Mysterious Voice.—"Some time ago," says a correspondent of *La Nature*, "I was walking around in a side show in which were exhibited mechanical portraits, when I was surprised to hear myself called: 'Monsieur! Monsieur!' . . . "I discovered that the voice came from a tin

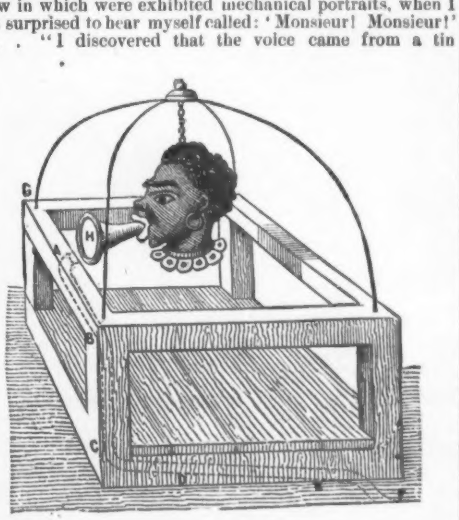


FIG. 1.—THE SPEAKING HEAD.

trumpet, which was held in the mouth of a negro's head made of wood, and suspended by a small brass chain from semicircles of iron supported by a wooden frame" (Fig. 1) The effect produced on the spectators by this speaking head was one of universal astonishment, and no one was capable of solving the mystery. The arrangement for producing the illusion is very simple, however, and is thus explained by the writer above referred to:

A person hidden behind the scenes speaks into a tube two or three centimeters in diameter which runs from that point to the wooden frame, and in the interior of the horizontal

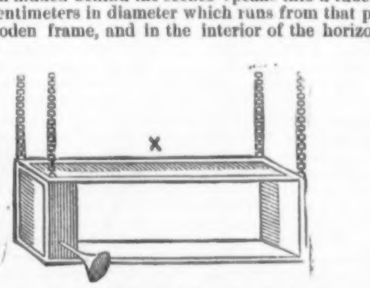


FIG. 2.—THE SPEAKING GLASS CASE.

and upright pieces of which it passes till it reaches the suspended head, at A, as shown by the dotted lines, E, D, C, B, A. The voice thus transmitted is reflected from the sides of the trumpet, H, to the person holding a conversation with the head.

The Invisible Girl.—This experiment, which is analogous to the one that precedes, was explained by Nicholson, in 1832, in his *Journal de Physique*. Although at first offered as a physical experiment, under the title of an "experiment in acoustics," it has since changed name and master, and is now dignified by the imposing name of "invisible girl."

Fig. 2 shows the arrangement of the original apparatus, which consisted of a glass case, X, about four feet long by about one in height, suspended from the ceiling by four chains at a distance of a foot from the window frame. From the extremity of the case projected a speaking trumpet, and the entire apparatus was surrounded by a latticework of iron wire to prevent its being touched by the hands of the curious. The phenomenon, although a puzzling novelty at the time, did not attract much of a crowd, as it was not managed with sufficient address, and the surroundings were not of a nature to please fashionable people. This apparatus was improved upon and rendered more elegant in appearance by Prof. Robertson. Fig. 3, copied from an old engraving, shows this latter arrangement. A globe, A, made of glass or enameled sheet iron, and to which are attached four trumpets, is suspended from the middle of the room. This globe is not necessary for the experiment, but is only an accessory to impose upon the imagination. Around it is placed a framework, B, which is very necessary, for it is hollow, and it is through it that the voice of the invisible person is heard. A tin tube passes through the upright, C,

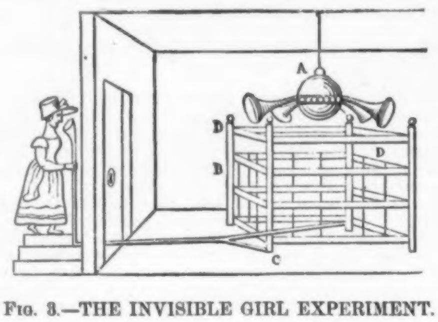


FIG. 3.—THE INVISIBLE GIRL EXPERIMENT.

and then runs to D, where there is a small slit or aperture opposite the trumpet. This tin tube passes under the floor of the room, and runs into the neighboring room, whence the pretended invisible person speaks, and sees everything through the keyhole or through an aperture in the wall. This is all there is of the mystery.

GARDEN DESTROYERS.

HORNETS AND WASPS.

(*Vespa crabro and V. vulgaris.*)

THERE are few insects which are better known or more cordially disliked than the common wasp. The hornet is by no means as common, and is fortunately comparatively a rarity, as its large size and powerful sting make it indeed a formidable insect to meddle with. Both, however, have many good qualities. They are remarkable for their boldness and pertinacity. If driven away, they will return again and again, and are by no means the useless insects they are generally supposed to be. They are often of considerable service in destroying grubs, caterpillars, and flies. They also kill daddy-longlegs, spiders, and bees, though killing the latter cannot in any way be considered a service. It is said that in some parts of America the farmers hang hornets' nests in their sitting-rooms to get rid of the flies. One would imagine that this remedy would be worse than the disease. Unfortunately, these insects do not confine themselves to animal food, but attack ripe fruit of all kinds. Some persons imagine that they do not touch fruit unless it has already been injured by some other insect or means, but this I cannot think is the case, as the jaws of a hornet or wasp are quite strong enough to cut through the skins of such fruits as they feed upon. Wasps are very hard-working insects. One which was watched by Sir John Lubbock made 116 journeys in one day from its nest to some honey in Sir John's study. It was at work when he entered the room at 4 A.M., and did not cease working until 7:47 P.M. Each visit was duly noted, and during the whole time, except after the first two visits, it was not away from the room for more than ten minutes together. One hardly knows which to admire most, the industry of the wasp or the observer. Hornets are said to work even harder than wasps, as they will at times work all night, particularly if it be moonlight. Many persons imagine that insects can communicate freely with others of their own kind, but it seems almost certain that wasps cannot. Sir John Lubbock several times marked wasps and watched them, noting the number of journeys they made, and in very few instances did other wasps come to the honey, which undoubtedly they would have done had they known of its existence, and those who did would have communicated their knowledge to the others if they could, as it would have been for the benefit of the nest generally.

The sting of a wasp is a very complicated apparatus, and consists of several parts, as shown in Fig. 3. The actual sting, A, is smooth, somewhat curved, and of a horny substance; it is channeled beneath, in which groove lie two hair-like organs, that can be protruded beyond the point of the sting, called spiculæ; one of these, C, is shown withdrawn from its proper position. These hairs are barbed at their points (Fig. 4), and are the chief factors in making the wound; they are separated at their bases, and are brought round the swollen termination of the sting, where they are attached to the muscles which move them. The poison bag, D, is connected with the sting by a fine tube, and is composed of muscles, which can evidently contract with great force. When not in use the sting is moved forward and protected by the two sheaths, B. When the wasp uses the sting it is thrown quickly backward, the two barbed hairs are rapidly worked in and out with a saw-like motion, the poison is ejected at the same time, and enters the wound as it is made. When stung the best thing to do is to suck the place well or to make it bleed, and then rub in hartshorn or ammonia in some form, sweet oil, washing soda, or the juice of an onion; if the sting is very painful, keep as quiet and cool as possible; anything which tends to make the blood circulate freely should be avoided. It is useless trying to kill wasps on a small scale if a nest is near at hand; when we consider that a nest, when in full working order, probably contains from 20,000 to 30,000 inhabitants, what difference shall we make if we kill a few hundreds? Later, however, in the autumn, queen wasps may be found about houses and out-buildings, searching for sheltered places to winter in, or early in the spring, having just left their winter quarters; these should always be destroyed, as each queen will make a separate nest. Windows in lofts or lumber-rooms to which wasps have access (and they will creep in anywhere) are capital places for finding them in the spring. The wasps, having found snug quarters, remain torpid until aroused by the warmth of the first mild, sunny weather; they then naturally fly toward the light, and may be found vainly trying to get out through the windows. Probably one of the chief reasons that wasps are so much less plentiful in some years than in others is that the queens are killed soon after leaving their winter shelter; tempted out by a warm day or two, they fall victims to a sudden change of weather against which they have no protection, unable to regain their winter shelter and not having commenced a nest. Insects when hibernating seem able to stand a great amount of cold, but when in full animation cold seems to paralyze them. As soon as the nests are found, by far the best means of killing wasps is to destroy the nests at night, when all the inmates are at home. Various methods have been devised for effecting this; among the best are the following: Rags dipped in coal tar, pushed into the entrance of the nest, and then lighted; cotton wool dipped and well saturated in a solution of cyanide of potassium (use just enough boiling water to dissolve the cyanide), and thrust with a stick into the hole, will kill the wasps, or two ounces of cyanide of potassium dissolved in one pint of water, poured into the nest. This drug is a very violent poison, and should be handled with great care. A lighted squib, composed of about equal parts of brimstone, gunpowder, charcoal, and saltpeter in a stout brown paper case, pushed into the entrance of the nest, rags dipped in melted brimstone, or flowers of sulphur thickly sprinkled on cotton wool, lighted, and kept burning if necessary by means of bellows so that the fumes must enter the nest, or hot tar gas poured into the nest. A turf should be placed over the mouth of the nest as soon as possible afterward to prevent the fumes from escaping, whatever plan may have been tried, and the nest should be dug up the next morning to insure the entire destruction of its inhabitants. Wide-mouthed bottles filled with beer and sugar, or treacle and water, hung on trees or walls which have ripe fruit on them will catch a great many and attract them from the fruit. A female wasp which has survived the winter and the perils of early spring begins looking about for a suitable place in which to make her nest. She usually chooses a convenient hole in a bank, and at once commences a few combs under an umbrella-like covering, entirely unassisted. The nest, both covering and combs, is constructed of a gray paper-like material, formed of fine fibers of wood, which she gnaws from palings, gateposts, or any woodwork which may be most convenient. These fibers are mixed with an adhesive secretion from her mouth. The nest is begun from the top and built downward. The first cells are not finished at once, but as soon as they are large enough an egg is laid in each, and they are enlarged from time to time. By this means the young wasps are reared some days earlier than they would have been otherwise, and are thus able all the sooner to assist in the construction of the nest.

The combs, unlike those of the honey bee, which are vertical, are horizontal, and the mouths of the cells are downward; the nest when finished is oval, and measures 16 inches or 18 inches from top to bottom, and 12 inches or 13 inches in width, and contains from twelve to fifteen tiers of combs, which are placed about half an inch apart, and are attached to one another by small columns. The outside of the nest is a casing of several thin papery layers, with spaces between them, which keeps the combs dry and prevents any intruders from getting into the nest except through the entrance. A large nest sometimes contains as many as 16,000 cells, and as each cell is supposed to be used three times in the course of the season, it has been calculated that a large nest before the close of their year will contain some

Fig. 1.—The Hornet (*Vespa crabro*). 2.—The Wasp (*Vespa vulgaris*). 3.—Sting of the Wasp (magnified). 4.—Barbed Point of one of the Spiculæ.

30,000 individuals at least. It must always be remembered that wasps do not store up honey or pollen, as bees do, so that their cells are only used for rearing their grubs in. The cells in the lower tiers are larger than those in the others, and in these are reared the males and females. As the mouth of the cells is downward, the egg is attached to the top of the cell by a glutinous secretion. The young grubs are also kept in the cells in the same manner, but when they are more mature the size of the front segments of the body prevents them from falling out. The grubs are hatched about a week after the eggs are laid. At first they are fed with the sweet juices of fruit or honey, but afterward animal food is also given them. Those who have had an opportunity of watching them describe the grubs as opening their jaws to be fed just as a young bird does its beak. The grubs are full grown in about a fortnight, after which they become chrysalides. From these, in the course of a week or ten days, the perfect wasps appear, who within a few hours begin to assist their mother in enlarging the nest, adding fresh combs, and feeding the grubs. The early wasps are all neuters, or, rather, imperfectly developed females. The males and females do not appear until September. They take part in the work of the nest like the neuters; the males, however, do not build or feed the grubs, but act as scavengers at the end of the season There may be 200 or 300 females in the nest, who do not in any way interfere with one another as queen bees do. Before the cold weather sets in the females are impregnated by the males, who die soon afterward. About this time the neuters, who seem to

know that the grubs still in the cell cannot live long enough to become wasps, drag them out and destroy them. The females then disperse in search of winter quarters, and the neuters gradually get fewer and fewer. Hornets in their economy much resemble wasps, but they usually select hollow trees or the eaves of hothouses, barns, etc., to build their nests in. There are two species of wasps which are equally common in this country, Vespa vulgaris and Vespa germanica. They resemble one another so closely that it is by no means easy to distinguish them apart; besides these two species there are four others which are not so common.

Vespa vulgaris (Fig. 2) may be described as follows: The females measure from five-eighths of an inch to six-eighths of an inch in length, and nearly 1¼ inches across the wings; the neuters are half an inch or rather more in length, and a large male is about the same size as a small female. The coloration in all is the same. The head is black, with two yellow spots on the face—one between the antennæ, which are black, and one behind and in front of each eye. The thorax is black and hairy, with a yellow line on either side, and two pairs of yellow spots near the base. The body is yellow, each joint having a black band in front, which is widest in the middle, where it is produced into an angle; it then narrows very rapidly to the sides. Behind this band on either side is a round black spot. Wasps have four wings, the lower pair being furnished with fine hooks, with which they can be attached to the upper ones. The upper wings, unlike those of bees and most insects, are capable of being folded longitudinally, and the wings are generally so folded when they are not in use. The legs are of moderate length. The thighs are black, except at their tips, which with the rest of the legs are yellow. The grubs when fully grown are nearly three-quarters of an inch in length, and are fat and fleshy, with their joints very distinctly visible. They have no legs, their heads are small, and are furnished with a pair of jaws. The chrysalides much resemble the perfect insects in form with their limbs closely folded to them. The hornet (Vespa crabro, Fig. 1), is much larger than the wasps, and may at once be distinguished from them by their general reddish brown color, having no black or pale yellow markings. The females are from 1 inch to 1¼ inches in length and measure nearly 2 inches across the wings, and the neuters five-eighths of an inch to seven-eighths of an inch in length. The general color of the insect is reddish yellow with darker markings. The eyes are nearly black, and the antennæ reddish brown. The thorax is of the same color, with a darker triangular patch on either side. The first joint of the body has a dark reddish brown band behind the middle, and the second has a curved irregular band of the same color. This band is almost wanting in the third joint, only a small triangular spot being visible, on either side of which is a small round spot. The fourth and fifth joints have a dark spot on either side. The legs are reddish brown, and the wings yellowish with brown veins.—*G. S. S.*, *in The Garden.*

THE TENDONS OF WHALES.

To the Editor of the Scientific American:

I wish to call your attention to a fibrous substance which can be obtained in large quantities, and which has so far been thrown away, or rather not saved, which seems to me should be utilized. I refer to the tendons of whales. Several years ago Mr. Callender, an eminent English surgeon, at a meeting of the Clinical Society, of which he was president, showed a specimen of ligature made from the tendon of a kangaroo. He thought it superior to those made from catgut, and regretted that the supply would be limited, as the kangaroo was nearly extinct. I wrote to him that whales' tendons could be obtained by the ton, and sent him a sample. He wrote to me in return that he thanked me for the suggestion; that he had used some on arteries and liked it better than catgut, because it did not absorb so quickly. He advised me to get some made up as catgut ligatures are made, and put them in the market. He said he was coming to Boston soon, and would call on me. But I could not find any manufacturers of violin strings in the States.

Mr. Callender came to the United States, was taken sick in Philadelphia, started for home, and died on the way. No other surgeon has taken any interest in the matter. But it can be used as a substitute for rattan for seating chairs. I had a stool bottomed with the tendons, while soft. They shrank somewhat in drying, and made a bottom firm like a drum head. I have used it three years to stand on to reach goods on the shelves; have jumped on it a great many times, coming down on the points of my boot heels. My weight is 170 pounds, and the stool is not at all injured. It seems to be indestructible. Mr. J. Cook, Superintendent of the Cape Cod Oil Works, at Provincetown, supplied me, and I suppose will supply more. The pieces I have are seven feet long. If any one should want what I have to experiment with, I would give it. The fibers could be separated and twisted into ropes, which could never be broken. Aside from these two, I can think of no use to which it can be put. I was once a whaleman, and my son now is, and I know that the tendons could be saved with but little trouble.

Boston, 1883. J. T. GILMAN.

WHALE SKELETON FROM GRAVEL ON THE LINE OF THE CANADA PACIFIC RAILWAY, NEAR SMITH'S FALLS, ONTARIO.

By J. W. DAWSON.

BONES of large whales are not of infrequent occurrence on the less elevated terraces of the Pleistocene period on the Lower St. Lawrence. I have seen them at several places in the neighborhood of Metis, on the lowest sea terrace, now elevated only a few feet above the level of the sea, and they are reported to have been found on the second terrace at an elevation of 60 to 70 feet. Mr. Richardson, late of the Geological Survey, informs me that he has seen them in several other places on the lower terraces. It has also been reported that bones of a whale were found on Mt. Camille, in rear of Metis, at a considerable elevation; but Mr. Richardson, who visited the locality, failed to verify the statement. The bones found on the lower, and therefore modern terraces, are usually in a good state of preservation, and have a very recent appearance. The above statements relate to remains of the larger whalebone whales.

Remains of the *Beluga*, or small white whale, were found by the late Dr. Zadock Thompson, author of the "Natural History of Vermont," in the marine clay in the township of Charlotte, Vermont, at an elevation of 150 feet above the sea. They were associated with shells of *Saxicava* and *Leda*. The species was supposed to be distinct from the *B. Catodon*, Gray, and was named by Thompson *B Vermontana*. I have found detached bones of *Beluga* in the Post-Pliocene clays of Riviere du Loup, and considerable portions of a skeleton were found in the excavations for the Intercolonial Railway, on the south side of the Baie des Chaleurs, and were described by Gilpin in the Transactions of the Nova Scotia Institute of Natural Science.* Bones have also been found in the brick clays near Montreal, and a specimen was discovered several years ago in sand holding *Saxicava*, near Cornwall, Ontario. The last named specimen was studied by Mr. Billings, and its bones compared with those of the modern species in the McGill College Museum. On this evidence Mr. Billings concluded that it belonged to the modern species, and I believe extended this conclusion to Dr. Thompson's specimen; the distinctive characters of which, as stated by that naturalist, seem not to exceed the individual differences in modern specimens.

But though the *Beluga*, which now extends its excursions far up the St. Lawrence, and has even been captured in the vicinity of Montreal, occurs as far west as Cornwall, no remains of the larger whales have, so far as I am aware, been found so far inland, until the discovery of the specimens referred to in the present note. These were found, as I am informed by Archer Baker, Esq., General Superintendent of the Canada Pacific Railway, "in a ballast pit, at Welshe's, on the line of C. P. Railway, three miles north of Smith's Falls, and thirty-one miles north of the St. Lawrence River, in the Township of Montague, County of Lanark. They occurred in gravel at a depth of 30 feet from the surface, and about 50 feet back from the original face of the pit."

Mr. Peterson, C. E., has been kind enough to obtain for me the elevation of the place where the remains were found, as indicated by the railway levels. It is 420 feet above the level of the St. Lawrence at Hochelaga, or as nearly as possible 440 feet above sea-level. It is interesting to observe that this corresponds exactly with the height of one of the sea terraces on the Montreal mountain, and is only 30 feet lower than the well marked beach with sea shells above Cote des Néiges, on the west side of the mountain. The highest level at which Post-Pliocene marine shells are known to occur on Montreal mountain is near the park-keeper's house, at an elevation of about 520 feet. These marine deposits of Montreal are of the same geological period with the cetacean remains in question, so that the animal to which these belonged may have sailed past the rocky islet, which then represented Montreal mountain, at an elevation of 400 feet above the lower levels of the city, and in a wide sea which then covered all the plain of the Lower St. Lawrence.

The deposit in which the remains occurred is no doubt the equivalent of the Saxicava sand and gravel, and was probably a beach or bank near the base of the Laurentian Hills, forming the west side of a bay which then occupied the Silurian country between the Laurentian Hills north of the Ottawa, and those extending southward toward the Thousand Islands, and which opened into a wide extension of the Gulf of St. Lawrence, reaching to the hills of Eastern Canada and New England, and westward, perhaps, to the Niagara escarpment at the head of Lake Ontario. Such a sea might well be frequented by whales in the summer season, and individuals might occasionally be stranded on shallows, or driven ashore by gales or by the pressure of floating ice.

The bones secured consist of two vertebræ and a fragment of another with a portion of a rib, and others are stated to have been found. They are in good preservation, but have become white and brittle through the loss of their animal matter. On comparison with such remains of whales as exist in the Peter Redpath Museum, and with the figures and descriptions of other species, I have little doubt that they belong to the Humpback whale, *Megaptera longimana* of Gray, *Balaena boops* of Fabricius, a species still common in the Gulf of St. Lawrence, and which extends its range some distance up the river, and is more disposed than most others of the large whales to haunt inland waters, and to approach the shores. I have seen it as far up the river as the mouth of the Saguenay, and there is reason to believe that occasionally it runs up much further. It is a species well known to the Gaspé whalers and often captured by them. Of course with so little material it is not possible to be absolutely certain as to the species, but I think it may safely be referred to that above named. The larger of the two vertebræ, a lumbar one, has the centrum eleven inches in transverse diameter, and is seven inches in length. The smaller, a dorsal, is ten inches in its greater diameter, and four in length. Through the kindness of Mr. Baker the specimens have been deposited in the Peter Redpath Museum of McGill University.—*Canadian Naturalist.*

CURIOUS FACTS ABOUT ANIMALS.

UPILIO FAIMALI† was one of the earlier of those performers who travel about with caravans of wild beasts, and who minister to public curiosity by entering the dens of lions, tigers, leopards, etc., engaging in mimic combat with these monsters, and compelling them to perform a variety of tricks. The taste for these exhibitions Prof. Mantegazza rightly pronounces a survival—the last remnant of the taste which led the most delicate ladies of ancient Rome to gloat on the savage games of the circus. So far is this instinctive bloodthirstiness from being eradicated, that nothing save the law prevents combats of wild beasts and gladiators from being revived in our unco' good humanitarian and bestiarian England. On reflection it does indeed seem strange to see a community suppressing by their united action what a majority of them in their hearts approve of, and, conversely, compelling by law or custom what they individually dislike. Of such action the instances are not few.

Upilio Faimali was an Italian—a son of the nation which supplies the world with professional athletes. We may ask if this aptitude for performances requiring strength and agility is not an inheritance of the physical training which for so many generations characterized the ancient Romans more than any other people of the past or the present?

Be this as it may, Faimali was from a very early age distinguished for muscular power, activity, courage, and presence of mind. In his eleventh year he obtained an engagement in Didier's circus, and five years afterward he astonished his employer and delighted the public with the equestrian performances of an ape which he had trained in secret. From that time his rise was rapid, and he soon possessed a menagerie of his own, with which he visited the chief cities of the Continent, and everywhere successful. His adventures and his hair-breadth escapes we must pass over, mentioning merely that his favorite dressing for wounds was a mixture of finely pounded sugar and brandy. But we turn with especial interest to his observations on the various animals which were for so many years his constant and close companions. The first point to be noted is one which bears upon the distinct nature of species. Many experiments at hybridization have, we know, failed, the young half-breeds produced being brought into the world dead, or surviving but for a short time. But so greatly is the reproductive power of many animals affected by changes of climate, of diet, and other conditions, that their young of unmixed blood, born in captivity, rarely survive. Faimali had about eighty lion-cubs born in his menageries, but none of them survived beyond the third or fourth year. Young leopards generally died before the end of their first year, or became paralytic. The young of many other species are weak, and suffer from rachitis. A singular fact is that the mother often kills the young brood, or at least refuses to suckle them, unless kept in darkness for several days after their birth. This circumstance is noted in the case of the hyæna, the wolf, the lioness, the panther, and the tigress.

In docility, intelligence, and disposition toward mankind the large carnivora differ greatly. The leopard is probably the most docile and affectionate; the jaguar less easily trained, and probably a more dangerous playfellow than any other member of the cat family; it cannot easily be made to let go whatever it has once seized.

In one and the same species Faimali recognizes individuality as distinctly as in man. The degree of docility depends, according to him, upon the varying power of attention. The education of beasts should not be undertaken too early; a lion learns best in his third or fourth year. If taken in hand too soon, he becomes confused, and is spoiled. It is remarked that lions from the Cape are cleverer and more docile than those from the Sahara or Senegambia.

The hyæna is pronounced to be the most stupid of all the animals exhibited in menageries; "it shows no attachment to its keeper, no gratitude for kindness, learns nothing, and is influenced only by fear."

Faimali possessed a very large white bear, but never entered its cage, as it never would obey him. With the black bear of Europe he often went through his performances, sometimes not without danger. We do not learn that either he or any of his contemporaries or successors ever attempted to tame a "grizzly." We suspect this would prove a desperate undertaking.

Faimali's observations on apes and monkeys are in conformity with the views of the New School. He considers the chimpanzee the most intelligent animal which came under his observation. He notes that he never saw one of this species "perform the last stage of digestion" in public. This is an instance of decency superior to that shown by many of the human race, and contrasts glaringly with the conduct of apes of the baser sort, from whose actions even Till Eulenspiegel might have learnt new lessons in impropriety. Faimali notices also the intense attachment of monkeys and baboons for their mates: the male and female often die of grief if separated.

Animals of the cat family, if born in captivity, suffer much when cutting their teeth. Those caught wild are apt to perish of pulmonary consumption, a disease which is still more common among the Simiadæ, and which, curiously enough, generally terminates the career of the trainers and keepers of wild beasts.

In opposition to many high authorities, Faimali pronounces the lion stronger than the tiger, though the latter is more agile and uses its canines with greater skill. The two species rarely agree together.

RECENT EXPLORATION OF THE VOLCANIC PHENOMENA OF THE HAWAIIAN ISLANDS.

By Captain C. E. DUTTON.*

RETURNING from my long visit to the Hawaiian Islands, I feel that I owe it to you to make some return for the kind interest you took in my journey and for the valuable suggestions you made me prior to my departure. I therefore avail myself of a convenient opportunity to tell you briefly some of the matters which most particularly interested me.

After making such purchases as were thought necessary for my journey at Honolulu, I took the inter-island steamer for the southern part of Hawaii. I did not go to Hilo at first, as travelers generally do, for after making inquiry I came to the conclusion that the southern part of the island would be a much more advantageous position from which to begin the study of Mauna Loa and Kilauea. The Hilo side of the island is very rainy. The field geologist quickly gets accustomed to every inconvenience and discomfort of travel except one, and that is mud; and the more he has to do with mud, the more he hates it. The southern district of the island, Kau, is almost always dry and the traveling good enough. I fitted out a pack-train with six packs, in regular Rocky Mountain style, and my first journey, of course, was to Kilauea. It is far pleasanter to approach the volcano from the Kau side than from the Hilo side, and the journey was full of interest. My first visit to Kilauea lasted ten days, during which I explored the great pit thoroughly and also the country round about. If I can rightly estimate the accounts of observers who saw Kilauea forty years or more ago, I should infer that the total amount of volcanic energy now manifested there has very considerably diminished. There is difficulty, however, in forming an estimate of how much allowance should be made for the enthusiasm and excited imaginations of travelers, who, for the first time, and generally the only time, have beheld this wonderful spectacle. The great inner pit, which was first described by Ellis in his Polynesian Researches, in 1823, and also by yourself, in 1841, has been completely filled up. The great outer cavity also has, I infer, become notably shallower, having been partially filled by innumerable overflows of lava. The inner cavity, which once held a burning lake, is now represented by two lakes, whose united surfaces have, I should judge, an extent which is but a small fraction of the surface of the old lake of forty or fifty years ago. These two lakes are both situated with their surfaces at levels higher than the mean level of the main floor of the pit. I infer too that they are much more languid and sluggish in their action than the lake which you saw.

The height of the walls surrounding the pit varies from 320 to 740 feet. There is abundant evidence that the floor of the pit sinks down more or less after every eruption within it, but presumably not to so great an extent as to compensate the building up of the floor after the successive out-pours of lava, so that, on the whole, the pit is probably growing shallower.

I watched with the deepest interest the action of the lava in the lakes. The most accessible one is now called the New Lake. It undergoes a series of regular changes within a period of about two hours. When we reach the brink of it,

* Volume II., 1874.

† Upilio Faimali; Memoirs of a Tamer of Wild Beasts. Collected by Paul Mantegazza.—*Journal of Science.*

* From a letter to J. D. Dana, dated Washington, D. C., Feb. 5, 1883.—*American Journal Science.*

we generally find it frozen over and quite black and still, except at the edges, where we perceive a rim of fire. We observe also at many places upon the edges a little sputtering and blowing out of lava, and hear a dull, simmering sound. At length a piece of the black lava upon the surface cracks, turns down its edge, and sinks, disclosing a patch of livid fire. Soon after in some other part of the lake, at the edge, another piece breaks and goes down. This becomes more and more frequent until at last a hundred cracks suddenly shoot through the entire surface, and with a grand commotion numberless fragments of the frozen surface plunge downward, leaving the whole one glowing mass of lava. For a few minutes the spectacle is very grand, but it does not last long. The surface quickly darkens and freezes over again, becoming black as before, and in this condition it remains for an hour or two. The period between breakups is not regular, being as short as forty minutes and as long as two hours and a quarter.

The explanation of the phenomenon is, I think, not difficult. When the lava first passes from the liquid to the solid condition, while its temperature is still near the melting point, but below it, its density is less than that of the lava below. As the crust thickens and the surface becomes cooler, its density becomes greater than that of the lava below, and its position then becomes unstable. A slight disturbance produces a rupture, and the sinking of one fragment is quickly followed by that of the others.

It has been the custom to speak of Kilauea as being situated upon the flanks of Mauna Loa, and to regard it as a mere appendage of that mountain. But it presents itself to me as a distinct volcano, having no more connection with Mauna Loa than Mauna Kea has. Into the discussion of this I cannot now enter.

From Kilauea I went to Mauna Loa. My first objective point was the source of the last great eruption of 1880–81. It is reached with difficulty on account of the roughness of the clinker fields, or *aa*, as it is termed in the islands. The vents are situated from twelve to eighteen hundred feet below the summit, upon the northeastern spur. Three distinct streams flowed from as many vents, one flowing northward to the base of Mauna Kea, a second flowing southward into Kau, and the third, and by far the largest, flowing first northward, then deflecting eastward until it came within half a mile of Hilo. This latter stream was about fifty miles in length and varied in width from half a mile to two miles. The appearances presented at this point I shall describe at a future time. It may be sufficient to state here that a series of parallel fissures pointing from the summit toward the base of the mountain gave issue to the lavas. No cone was built, and there is no accumulation whatsoever of fragmental eruptive products.

I was deeply impressed with the colossal character of the eruptions of Mauna Loa. Of the eruptions which bear historic date, that of 1855 appears to have been the grandest. It would have almost built Vesuvius. The accounts given to me by many eye witnesses of these eruptions recite observations which strike me as most extraordinary, though I cannot for a moment question the general truthfulness of these accounts, attested by so many intelligent and credible witnesses. The general version is that they break out suddenly and without warning, and that the lava spouts upward in enormous fountains to a great altitude, which the various observers estimate all the way from 500 to 1,000 feet. How much of this may be attributed to incandescent steam and how much to optical illusion of one kind or another it is impossible to say. But I cannot doubt the general testimony that these vast lava fountains do spout upward to a very considerable height, and that the fires which are actually seen are mostly lavas. I think there is substantial evidence of this in the appearances presented at the sources of the great eruptions of 1855, '59, and '68. Dr. Coan visited the source of the eruption of 1855 while it was still active; and about three months before his death I had the privilege of inquiring of him very particularly about this matter, and his account substantiates the general testimony.

One of the most striking features of Mauna Loa is the almost total absence of cinder cones. There are a few small piles of fragmental material here and there, but they are mere apologies for cinder cones, and are very aberrant in their modes of aggregation and in the character of component materials. Considering the portentous nature of these monstrous outbreaks, it is wonderful how little disturbance attends them. No earthquakes, no rending and shaking of the mountain nor roar of escaping vapors, no vast clouds of steam, but simply a huge river of fiery lava welling forth like water from a fountain and flowing swiftly on its course down the mountain side. So far as I have ever heard, this quiet character of the eruptions, the absence of fragmental products, and the insignificant amount of elastic force exerted by escaping vapors are without a parallel.

All of the great eruptions of Mauna Loa come from fissures which point from the summit of the mountain directly down its slopes.

I visited the great pit at the summit of Mauna Loa twice from two different lines of approach. It is very nearly equal in its horizontal extent to Kilauea, but it is much deeper, being about a thousand feet in depth, and is a much more impressive spectacle. It was absolutely still, without a trace of igneous action at the time of my visit. Before the last great eruption it was in a state of intense activity, spouting out lava in jets which attained a height of seven or eight hundred feet, and the igneous phenomena were, judging from all accounts, far more impressive than those of Kilauea. The glare of its fires was seen a few days before the last eruption; but it would seem that as soon as the last eruption began, the vents at the summit immediately sealed, up, being tapped, I presume, by the outbreaks which occurred at a considerably lower level.

The lavas of both Kilauea and Mauna Loa seem to me to be of an abnormal type. The analyses are not yet made, and I can therefore give only their superficial character. They have the appearance of being extremely basic, decidedly more so than normal basalts. I cannot help thinking that they may be fairly relegated to what Judd describes as ultra basalts. Most of the lavas of Mauna Loa contain excessive quantities of olivine, many specimens being at least half composed of that mineral. The lavas of Kilauea, on the other hand, whether in the pit itself or in the country round about, seldom show much olivine. But the eruption of 1840, which belongs physically to the Kilauea group, is highly olivinitic, while the last eruption of Mauna Loa shows little or no olivine. I am led to suspect that the ultimate analyses of the two lavas, whether olivinitic or not, will show but little difference. In other words, I suspect that in some cases the olivine was crystallized in the lava before eruption, while in others it was not, the magma being very nearly identical in both cases.

I spent a great deal of time in the study of Mauna Kea. This volcano contrasts strongly in its aspect with Mauna Loa. Its lavas are apparently more nearly normal basalts, and show a somewhat wider range of variety. The most striking difference in the two mountains is the absence of fragmental products upon Mauna Loa and their great abundance on Mauna Kea. The latter mountain is covered all over with magnificent cinder cones of large size and beautiful proportions, which are, by far, the most striking features of its mass. Many superb cinder cones are scattered thickly around its base and over its great flanks, and a large cluster of them forms its summit. The activity of Mauna Kea has probably been extinct for a very considerable period of time. When we first look upon its cinder cones in a perfect state of preservation, the first impression is in favor of great recency in its activity, but a more careful study of the surroundings leads to a modification of this view. Upon the windward side of the mountain the ravages of time are very apparent and quite extensive. Upon the leeward side they are far less extensive, but are by no means wanting. During the past few years my attention has frequently been called to the very great inequalities of effects produced upon the same mass by varying degrees of energy in the agencies of degradation. Nowhere does it come out more clearly than in these islands. The windward sides in most cases have been devastated to an astonishing degree, so much so that I sometimes shrink from the task of trying to convince anybody of the reality which I am sure of. But on the leeward sides, which have undoubtedly been exposed for an equal period of time, the degradation is but a small fraction of what appears upon the windward sides.

The cause of the difference in the forms of Mauna Loa and Mauna Kea is very apparent; the former being built up entirely of fluent lavas, without fragmental products, and the lava streams being of great magnitude, the ejected material has diffused itself over a very wide extent of country and flowed many miles away from the principal focus of eruption. The mountain, therefore, is abnormally flat in its profile. In Mauna Kea, on the other hand, so large a proportion of the ejecta being in a fragmental form, they are piled up around the places where they were thrown out. The mass of Mauna Kea is many times smaller than that of Mauna Loa; but the top of its summit platform is only six or seven hundred feet lower than that of Mauna Loa, while the cinder cones upon the summit carry its apex about two hundred feet higher than the summit of Mauna Loa.

On all the slopes of Mauna Loa there is nowhere to be found anything like a ravine. Nor is there a single living stream, however small. And yet on all sides the precipitation is very great, but the water sinks as rapidly as it falls. The lava is highly vesicular and much broken, never compact, except in bands here and there, at the bases of the larger flows. Every lava stream gives rise to long pipes or tunnels and there are literally thousands of them, some of which are several miles in length. In truth, these long caverns must form an appreciable portion of the entire volume of the mountian. Remembering also the very vesicular character of the lava, it seems plain that while the absolute density of the materials is very high, the specific gravity of the mass as a whole is by no means so.

It appears to be a general fact throughout the islands that erosion does not take hold of these volcanic piles to any appreciable extent during their activity, and after they become extinct a long period must still elapse before surface erosion other than chemical weathering can begin. The cutting of ravines is impossible without running water, and the water cannot collect in streams until the cracks and pores of the lava are silted up. Of course, this takes place more quickly upon the windward than upon the leeward sides. These facts are abundantly illustrated on every island in the group.

I also visited Hualalai, which has an altitude of about 8,600 feet. It seems to be intermediate as regards the character of its lavas and many of its eruptions between Mauna Kea and Mauna Loa; being more basic than the former, less so than the latter. It has many cinder cones upon it, especially at the summit, some of which resemble those of Mauna Kea, while others have the abortive, abnormal, and dwarfed character of the very few which occur upon Mauna Loa. This volcano, it is well known, has been active in the early part of the present century. From 1801 to 1811 there were three distinct eruptions, separated by intervals of a very few years, but all of them were small. One of them, as nearly as can be made out, must have occurred about the year 1801, the second in 1805, and the last in 1810 or 1811.

Kohala mountain, at the north end of the island, is about 5,400 feet in height, and its activity, no doubt, ceased at an earlier period than that of Mauna Kea. Its lavas are largely normal basalts, much of it approaching andesite in character. It appears to be notably less basic on the whole than the lavas of Mauna Kea. It has many cinder cones, some of them perfectly well preserved, others showing conspicuous traces of decay.

My visit to Maui, though briefer than that to Hawaii, was very interesting. The great volcano Haleakala is about 10,400 feet high. The great "crater" (so-called) at the summit possesses a grandeur and impressiveness which have not been overrated by travelers who have heretofore described it. The form of this summit depression is certainly most extraordinary and not easy to account for. It is impossible, however, to describe this mountain briefly, and I shall not here attempt to do so. It is wholly basaltic, and in its general characteristics a pretty close imitation of Mauna Loa. The mountain piles which make up West Maui are much older. They are very much degraded by erosion and literally sawed to pieces by gorges and ravines two thousand to three thousand feet in depth, with precipitous walls. Some of the scenery in these gorges possesses a beauty and grandeur seldom equaled. It is highly peculiar, and so far as I know has its counterpart only in other islands of the Pacific. I found here some lavas which appear to be true andesites, though in the main the rocks are of a mildly basaltic type.

I also went over the island of Oahu pretty thoroughly. It has many points of interest, of which, perhaps, the most notable are the studies of erosion which it presents. I may make the same remark regarding the island of Kauai. It has frequently been noted that the western islands of the group are the oldest, and the antiquity diminishes from northwest to southeast. I consider the conclusion safe, however, only to this extent, that the eruptions in the western islands ceased at an earlier period, though it does not necessarily follow that they began any earlier.

There are abundant evidences of recent elevation in the islands, the amount of which varies greatly. In a few portions there are marked traces of subsidence, though on the whole the elevating movement has greatly predominated. This subject is too complicated to be discussed here.

It would be impossible for me now to give much idea of the new facts I have learned. I have made no grand discoveries, and of course I did not expect to. But I have picked up much knowledge of small details, the value of which no one but a geologist can appreciate; no nuggets, but a good deal of fine gold. I think I understand much better than I ever did before the action and behavior of lavas, their modes of accumulation and their methods of flowing. To some extent, no doubt, these observations relate to matters peculiar to the islands, and it would not be safe to consider them typical; but I imagine that their utility will not be less on that account.

One of the most pleasing studies in these islands is the climatology. In truth, there are about as many climates as there are square leagues; yet all of them seem to be reducible to ordinary and well known laws, and when understood form some of the most beautiful examples of the operations of those laws which can well be imagined.

LIFE-RAFTS.

According to the *Nautical Gazette*, much reliance cannot be placed on the use of air bags as life-rafts, for not only are they very liable to injury, but they rapidly deteriorate. Mark our words, says the journal in question, a metallic life-raft is the best in the market, but what is better still is a woven bamboo cylindrical raft filled with cork. It would outlast any ship, not being possible to stave alongside of a vessel, and be quite if not more buoyant than any other class of raft ever made.

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